DENISON UNIVERSITY BULLETIN

Volume XXXVI, No. 12

JOURNAL

OF THE

SCIENTIFIC LABORATORIES

Volume XXXI Articles 4–6 Pages 143 to 259

EDITED BY

W. C. EBAUGH

Permanent Secretary Denison Scientific Association

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GRANVILLE, OHIO

DECEMBER, 1936

The University Bulletin is issued bi-monthly and is entered at the Post Office in Granville, Ohio, as mail matter of the Second Class

JOURNAL OF THE SCIENTIFIC LABORATORIES OF DENISON UNIVERSITY

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JOURNAL

OF THE

SCIENTIFIC LABORATORIES

OF

DENISON UNIVERSITY

EDITED BY
W. C. EBAUGH

VOLUME XXXI
1936

GRANVILLE, OHIO

Published
April, August, December, 1936

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A STUDY OF THE VESTIGIAL AIR BLADDER IN THE DARTER (*CATONOTIS FLABELLARIS RAFINESQUE*)

GEORGE DAVID MORGAN

Received July 8, 1936; published February 22, 1937

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INTRODUCTION

An air bladder is present in all Osteichthyes with the exception of some specialized teleosts where it has become either degenerate or entirely lost. Particularly in the family Etheostomidae, the common fresh water "darters," we find forms having a much reduced air bladder, and others in which it is entirely absent.

At the suggestion of Dr. Raymond C. Osburn, Ohio State University, a study was made of the family Etheostomidae in order to determine the extent of the air bladder in these forms, its relation to the adjacent organs, and whether or not any evidence of an air bladder ever occurs in the life history of the forms in which it is absent in the adult. A study was also made of the origin, of the position in respect to the body somites and to adjacent organs of the embryos and adults of a few common forms which have an air bladder throughout life.

Grateful acknowledgment is made at this time to Professor Osburn for valuable suggestions and criticisms, for taking the photomicrographs, and for help in obtaining material for this work. Thanks are due also to Dr. A. W. Lindsey, Denison University, for photographing and printing the drawings used in this paper.

HISTORICAL REVIEW

The air bladder in fishes has been a valuable source of research for many years, not only because of its diversity of forms and its physiological nature, but also because anatomists have long considered it to be the forerunner of the lungs of the Tetrapoda. Owen (*28*), in his study of the African lung fish, *Protopterus*, maintained their homology. However, whether the various forms of air bladders in fishes are strictly homologous is still a much debated question since the origin of the bladder itself is not yet fully explained.

Few other organs show such a diversity of form as the air bladder. According to Geoffroy Saint-Hilaire (*36*) and Kerr (*16*) the most primitive air bladder is found in the Crossopterygian fishes. In *Polypterus* it is alveolar, lunglike, and is divided into two lobes, a short left one, and a long right lobe. It opens ventrally by means of a muscular vestibule into a glottis which communicates with the beginning of the esophagus. The air bladder for the most part lies ventral to the esophagus, only the right lobe being dorsal in position. In the Dipnoan fishes, *Lepidosiren* and *Protopterus*, the air bladder is bifid, dorsal in position, and exhibits such an alveolar structure that Cuvier compared it with the lungs of the reptiles. In the remainder of the Osteichthyes, the Actinopterygii, it is also variously formed. In the Perch it is a single blind elongated sac extending the entire length of the abdominal cavity. In the Carp, Tench, and other Cyprinidae, the organ is divided transversely into two portions which communicate with each other by means of a small opening, or the two compartments may have no communication, as in *Bagrus filamentosus* and in a species of *Cymnotus*. In the genus *Pangasius*, one of the Siluridae, it is divided into four longitudinal portions. In the Sapphirine gurnard, *Trigla trirundo*, the air bladder is divided longitudinally into three lobes, two small lateral lobes, and a larger median lobe. It is bilobed in all other Gurnards. In *Corvina trispinosa* the air bladder gives off two somewhat slender processes, one on each side, one extending dorsally, the other extending ventrally. The Maigre, *Sciaena aquila*, has an air bladder which is fringed along its edges into

numerous pneumatic caeca. In *Gadus navavagu* the lateral diverticula expand and line corresponding expansions or excavations of the abdominal parapophyses thus paralleling the pneumatic bones of birds. In *Campostoma anomalum*, according to Osburn (*27*), the very long intestine is coiled around the air bladder, a condition found in no other form. In some cases the air bladder is partially divided both lengthwise and crosswise as in *Cobitis fossilis*, in *Auchenipterus furcatus*, and in some species of *Pimelodus*.

In species below the Osteichthyes there is no positive evidence of an air bladder. However, Miklucho-Maclay (*23*) claims that a vestigial air bladder occurs in the embryos, and in some of the young forms of Selachians. He described the presence of a dorsal esophageal diverticulum which he assumed to be the rudimentary air bladder. P. Mayer (*19*), confirms the occurrence of a diverticulum only in *Mustelus*, but he also mentions the presence of two ventral diverticula in this region. Hence he doubts whether or not the aforementioned structure is really the forerunner of an air bladder.

The air bladder is occasionally absent also in the Osteichthyes. According to Houghton (*14*), it may be absent in fishes belonging to different genera, and even sometimes in fishes exhibiting merely specific differences, as for instance one surface-swimming mackerel has an air bladder while another species of the same habit is devoid of one. Again, in two species of sun fish of the genus *Orthagoricus* of the same habit one has an air bladder, the other has not. In the Pleuronectidae the air bladder is absent in the adult, but it is present in the free swimming larva of some forms such as *Rhombus*. Ehrenbaum (*8*) and Thilo (*38*) have also described its presence in other young forms of Pleuronectidae.

Thus the air bladder exhibits a variety of forms from the blind elongated saclike structure of the Perch, the numerous bifid forms both crosswise and lengthwise, to extreme specializations as shown by its division into numerous pneumatic caeca, through the lung-like forms of *Polypterus*, of the Dipnoids, and of the Ganoids, and to its presence and absence in different stages of the life history of the same species.

The air bladder usually opens into the esophagus by means of a pneumatic duct which was originally described by Needham in 1667. However, like the bladder, there is quite a variation in its position, its length, and its appearance.

In the lower fishes such as *Amia*, *Lepidosiren*, and the Chondrostei it is short and wide. In *Lepidosiren*, according to Wiedersheim (*42*), it is provided with a dorsal muscular vestibule. In the Crossopterygii, according to Geoffroy Saint-Hilaire (*36*) and Kerr (*16*), there is a similar muscular vestibule opening into the glottis which communicates with esophagus ventrally. Likewise, Parker (*31*) and Goppert (*10*) described the same structure in the Dipnoi. Here it opens to the right of the mid-ventral line. However, the bladder lies entirely dorsal to the alimentary canal. In the Teleostei the duct may become very narrow, reduced to a solid thread, or as in the more specialized Teleostei, it may completely disappear. The open duct is present in the lower Teleostei such as the Clupidae, Esocidae, Anguillidae, Cyprinidae, adult Gasterosteidae, Mugilidae, and Notacanthidae. The Acanthopterygii, with a few exceptions, have no ducts. In most Actinopterygii, the duct when present opens into the esophagus on the mid dorsal line. However, in some Teleosts, such as the Salmonidae, Siluridae, Cyprinodontidae, Percopsidae, and Galaxidae, it opens to the right of the dorsal median line. In Mormyridae, Notopteridae, Gymnotidae, Cyprinidae, and Characinidae, it opens to the left of the mid dorsal line.

According to Balfour (*4*) and Parker (*4*) the air bladder of the Ganoids originates after hatching as an unpaired dorsal evagination of the foregut directly posterior to the last gill arch. In *Amia Calva*, as reported by Piper (*30*), the air bladder originates as a groove-like dorso-median evagination of the oral part of the stomach-esophageal anlage. The groove constricts from behind anteriorly thus forming the communicating duct. In the Dipnoi the bladder originates ventrally, but the right lobe eventually assumes a dorsal position. K. E. von Bär (*2*) describes the development of the air bladder in the Teleostei as a dorsal evagination of the foregut. In the Physostomous fishes the pneumatic duct is then formed backward. According to C. Vogt (*40*) the

air bladder of *Coregonus palaea* makes its appearance as a solid mass of cells on the dorsal side of the foregut. In *Coregonus clupeaformis* it appears as a dorsal evagination of the foregut directly anterior to the liver anlage. Corning (*6*) states that in the salmon the air bladder makes its appearance in a 12 mm. long embryo. The esophagus, in this stage, is a solid mass of cells anteriorly. A distinct widening of the lumen occurs directly posterior to this solid area. At this point the out-pocketing of the air bladder anlage takes place dorsally, posteriorly, and towards the right.

Goodrich (*11*), in his discussion of the ancestral origin of the air bladder, favors the theory of Spengel. According to this theory it probably arose in the beginning from a posterior pair of gill pouches although no definite embryological evidence of this has yet been found. Spengel's theory is based on Goette's original suggestion, that the posterior pair of branchial pouches gave rise to the lungs. Thus he argues that a union of the right and left pouches ventrally would give us the condition found in *Polypterus* (Dipnoi and Tetrapoda). A fusion dorsally would result in the formation of the single bladder of *Amia*, and other Actinopterygii. However, the probable origin is not yet solved; but the above theory, according to Goodrich, is the most promising. This theory alone accounts for the blood supply being derived from the fourth arterial arch in the Dipnoi, *Polypterus*, and *Amia*. It is assumed that in the Actinopterygii, when either or both pouches became dorsal in position, the arterial supply was then drawn more directly from the dorsal aorta.

MATERIALS AND METHODS

Collecting of adults

Small and large forms of fourteen species of darters, white crappies, perch, and goldfish were collected in Lake Erie during the summers of 1932 and 1933 while the writer was attending the Theodore Stone Biological Laboratory at Put-In-Bay, Ohio. The larger forms collected were preserved in 10% formalin, while the smaller fish were placed directly in Bouin's fixing solution.

Collecting of eggs

Eggs used in the study of the embryology of *Catonotis flabellaris flabellaris* were collected in Cat Run near Granville, Licking County, Ohio, between April and June of 1934 and 1935. These eggs were abundant during the latter part of April and the month of May. They are found underneath flat stones in rather shallow water where as many as 500 eggs were counted beneath a single stone. These eggs are laid in parallel rows, and in a single layer. The identification of the particular species was made easy because of the habit of the male in remaining underneath the stone containing the nest, presumably to guard the eggs. The males during this period stay so close to the nest that they can be caught easily with the hands. To verify the identification, newly hatched forms were raised in a laboratory aquarium until identification was positive. Eggs were collected at intervals of 24 hours until time of hatching, when they were placed in an aquarium. A few of the newly hatched forms were removed at intervals of a few hours for fifty days. In this way a very good series of developmental stages was obtained, from early blastula through fifty days post hatching.

Eggs of the goldfish, *Carassius auratus*, were collected in Squaw Harbor, Put-In-Bay, Ohio. The eggs were found attached to most of the aquatic vegetation.

Preparation of adults

The adults, preserved in formalin, were dissected, and the extent of the air bladder was studied, as well as its relation to the adjacent organs, particularly the kidneys.

The smaller adults, fixed in Bouin's solution, were decalcified in an acid solution made up of 5 cc. of 5% nitric acid, and 95 cc. of 70% alcohol. They were left in this solution for three to five days until the bones were entirely decalcified. This was determined by pricking the tail vertebrae with a needle. After decalcification, washing, and dehydrating, the specimens were cleared in cedar oil after which they were placed in xylol and paraffin, in equal proportions, for one hour, and then in pure paraffin for

two to three hours. In this way excellent infiltration was secured. Sagittal and cross sections were then made. Some of the forms were stained with Delafield's hematoxylin and counter-stained with eosin. Others were stained in Mallory's connective tissue stain. Very satisfactory results were obtained with both of these stains.

Preparation of eggs and embryos

As soon as the eggs of *Catonotis flabellaris flabellaris* were collected they were placed in Bouin's fixing solution. Some of the eggs were punctured by pricking the egg membrane with a sharp needle. However, it was found that this procedure was unnecessary, as quite satisfactory results were obtained without pricking. After fixation the eggs were then preserved in 83% alcohol until ready for use. The egg membranes were then removed and the young embryos dissected off the yolk. They were cleared in cedar oil and placed in paraffin for one hour, and then sectioned and stained as described for the adult forms.

Some of the hatched forms placed in the aquarium were removed at intervals of one hour, two hours, 12 hours, 24 hours, and thereafter every 24 hours for 50 days. After fixing, the same procedure was followed as described for the embryos, with the following exception. Some of the post embryos were dehydrated in dioxan. This method, as described in *Turtox News, 12*, no. 5 (May, 1934), proved very satisfactory. However, a slight modification of this method was followed. The embryos were taken from 83% alcohol and placed in dioxan $\frac{1}{3}$-alcohol $\frac{2}{3}$; dioxan $\frac{2}{3}$-alcohol $\frac{1}{3}$; and pure dioxan. One hour was allowed for each of the above steps. A little melted paraffin was then added to the pure dioxan, and the vial was placed in a warming oven at about 50 degrees centigrade for three hours. They were then placed in pure paraffin for half an hour. Excellent results were obtained by this method.

The eggs of *Carassius auratus* were allowed to hatch in finger bowls in the laboratory, after which they were fixed and prepared for study as described for *Catonotis flabellaris flabellaris*.

Young post embryos of *Coregonus clupeaformis* were obtained

from Dr. J. W. Price, Ohio State University. The procedure followed for these forms was the same as described for other embryos.

Drawings

Drawings were made of the embryos and adults with the aid of the projectoscope. In this way accurate proportions and exact magnifications were easily obtained. The magnification was measured by projecting a counting slide used in the counting of blood cells onto a sheet of paper, and then computing the magnification from the known size of the squares on the counting slide, each small square being 0.05 mm. in diameter.

Photomicrographs

Photomicrographs were made of the vestigial air bladder of *Catonotis flabellaris flabellaris*, and *Carassius auratus*, Plates LXVII and LXVIII.

MORPHOLOGICAL DATA

Adult forms studied

The following adults were studied with the object of determining the presence of an air bladder, its extent, its relations to adjacent organs, and its degree of degeneration.

Darters
- *Percina caprodes caprodes* (Rafinesque)
- *Hadropterus maculatus* (Girard)
- *Hadropterus phoxocephalus* (Nelson)
- *Etheostoma blennioides* (Rafinesque)
- *Poecilichthys zonalis* (Cope)
- *Poecilichthys osburni* Hubbs and Trautman
- *Poecilichthys variatus* (Kirtland)
- *Poecilichthys coeruleus* (Storer)
- *Poecilichthys spectabilis* (Agassiz)
- *Poecilichthys exilis* (Girard)
- *Boleosoma nigrum nigrum* (Rafinesque)
- *Ammocrypta pellucida* (Baird)
- *Cottogaster copelandi* (Jordan)
- *Catonotis flabellaris flabellaris* (Rafinesque)

Other forms
- *Casassius auratus* Linnaeus
- *Pomoxis annularis* Rafinesque
- *Perca flavescens* Mitchill

In the adult of *Carassius auratus*, Figure 6, the air bladder lies free and extends along the entire length of the abdominal cavity. It is constricted transversely at about its middle into a large anterior part and a somewhat smaller posterior portion. A part of the anterior chamber is suspended laterally to the abdominal wall. In the region of this constricted portion of the air bladder there is a downward growth and an enlargement of the kidneys. From this region anteriorly the kidneys become reduced in size until they reach the anterior end of the air bladder where they enlarge and pass ventrally. This condition of the kidneys agrees with the observations of Moore, R. A. (*21*). *Carassius auratus* belongs to the physostomous group of fishes in which there is a pneumatic duct present connecting the air bladder with the esophagus as shown in Plate LX, Fig. 5 and Plate LXI, Fig. 6.

The abdominal cavity, in comparison with that of the darters, is rather short and deep. The alimentary canal is crowded ventrally in this rather short space. The liver is restricted to the anterior part. The left lobe extends posteriorly to the constriction of the air bladder. At this point it touches the downward growth of the kidneys.

The air bladder in *Pomoxis annularis* (Plate LXV, Fig. 17) extends along the entire dorsal region of the coelomic cavity. It differs from that of *Carassius auratus* in that it is fused with the peritoneum of the abdominal cavity along its entire length, and also in the absence of a transverse constriction and of a pneumatic duct. This form belongs to the physoclistous group of fishes. The extent of the coelomic cavity and the crowding of the viscera correspond very closely to those of the preceding form. However, the kidneys do not increase in diameter except in the anterior and posterior regions where they pass ventrally around the anterior and posterior portions of the bladder respectively.

The liver corresponds in position and in extent to that of *Carassius auratus* except that there is no elongation of the left lobe.

The relative position of the anterior part of the air bladder corresponds very closely to that of the preceding form.

In *Perca flavescens*, another of the physoclistous forms of fishes,

the air bladder is similar in position and extent to that of *Pomoxis annularis* except that it is slightly longer. It extends forward along the dorsal wall of the coelomic cavity as far as the fourth body somite. The kidneys and liver conform in shape and extent to those described for the preceding form.

In all these forms described the blood supply of the air bladder consists of a pneumatocystic vein which enters the portal vein, and an arterial branch from the coeliac artery.

In *Percina caprodes caprodes*, one of the largest of the darters, the air bladder though present is much reduced in size and extent. It is restricted to the posterior half of the abdominal cavity (Plate LXIII, Fig. 13 and Plate LXIV, Fig. 14) and is fused with the abdominal wall along its entire length as in *Perca flavescens*. The anterior walls of the bladder are thickened. Whether this is due to the degeneration of the air bladder in this region is uncertain. A study of the embryonic development of the air bladder in this form would be very interesting were the eggs of this particular species more easily obtainable. Here again it is interesting to note that the kidneys increase in diameter where the air bladder is absent. (Plate LXIII, Fig. 13.)

The liver increases slightly in length in this form in the region anterior to the air bladder.

The blood supply of the air bladder in this form corresponds to that of *Perca flavescens*.

In *Hadropterus maculatus maculatus* (Plate LXIV, Fig. 15 and Plate LXV, Fig. 16) and *Hadropterus phoxocephalus* an air bladder is present, but as in *Percina caprodes caprodes* it is restricted to a part of the coelomic cavity. However, it occupies the posterior two thirds of the length of the abdominal cavity. The walls of the anterior part of the bladder are again thickened in these forms, and extending anteriorly from this region is a strand of connective tissue. Here again the kidneys increase in diameter in the region where the air bladder is missing.

The liver also conforms in shape, extent, and position to that of *Percina caprodes caprodes*. The blood supply is also similar.

A careful dissection and sagittal and cross sections were made of all the other darters listed on page 150. In all these forms no

evidence of an air bladder was found. Plate LXII, Fig. 11 and Plate LXIII, Fig. 12 respectively will serve to illustrate *Catonotis flabellaris flabellaris*, and *Boleosoma nigrum nigrum*. The coelomic cavity in these darters is rather long and narrow. The kidneys extend from the anterior region to the posterior region of this cavity without any abrupt increase or decrease in diameter as shown in the preceding forms.

The liver in these darters is more elongate than in any of the forms previously described. It extends beyond the pyloric end of the stomach. It seems that the extent of the air bladder has a distinct bearing upon the shape and extent of the kidneys as well as upon the extent of the liver.

The elongate liver is a possible adaptation to the slenderness of the body forms of these fishes, living as they do in swiftly flowing streams. A fish in which the liver is restricted to the anterior part of the coelomic cavity would necessarily have to be broader bodied. Such a condition would be a detriment to life in such a habitat. The absence of an air bladder is also, possibly, correlated with the bottom habit of these fishes. An air bladder would add to the buoyancy of the fish, and would also tend to increase the diameter of the body. Such conditions would make it difficult for the fish to remain at the bottom of the stream and hence would expose the fish to the swiftly moving current.

A rudimentary air bladder

Since no air bladder was found in the adult stage of these darters the question arose as to whether or not any evidence of an air bladder occurs during the life history. Such a condition is true in the Pleuronectidae where an air bladder appears in the free swimming immature stages, and then becomes degenerate as the adult assumes the bottom living habits. Could such a condition be true also of the darters? With this end in view a study of the embryonic development of one of these forms was made. A study was also made of the embryos of several forms having an air bladder in order to determine the approximate position of the first evidence of the air bladder of these fishes.

Number of embryos studied

The embryos of the following forms were studied:

Carassius auratus Linnaeus
Coregonus clupeaformis (Mitchill)
Catonotis flabellaris flabellaris (Rafinesque)

According to H. K. Corning (*6*) the air bladder in the *Salmo salar* (Plate LXII, Fig. 10) appears in a 17 mm. embryo as a dorsal evagination of the foregut. This diverticulum is located in the second and third body somites slightly anterior to the liver mass. It appears as a short hollow tube made up of a single layer of endodermal cells, being nothing more than a backward fold of the esophagus in this region.

In a 5 mm. embryo of the goldfish, *Carassius auratus* (Plate LX, Fig. 5) the air bladder appears, as in the preceding form, as a dorsal evagination of the esophagus in somite two and extends backward to about the sixth body somite. The distal part, in this stage enlarges into the air chamber, while the proximal part becomes the pneumatic duct.

The air bladder in a 10 mm. embryo of the white fish, *Coregonus clupeaformis* (Plate LXI, Fig. 7 and Plate LXII, Figs. 8 and 9), appears as a dorsal hollow evagination of the esophagus in about the sixth body somite slightly anterior to the liver, and a little posterior to the region of the heart. Its position is only slightly posterior to those of *Carassius auratus*, and *Salmo salar*.

In all these forms the air bladder appears as a dorsal diverticulum of the anterior region of the esophagus in somites two to six. In the Ganoids, according to Balfour and Parker (*4*), it originates as a dorsal evagination of the foregut directly posterior to the last gill arch. Likewise in *Amia calva*, Piper (*30*), the air bladder originates as a dorso-median evagination of the oral part of the stomach-esophageal anlage. K. E. von Bär (*2*) describes the development of the air bladder in the Teleostei as a dorsal evagination of the foregut. Likewise Corning (*6*) states that in *Salmo salar* it appears as an out-pocketing of the stomach-esophageal anlage dorsally. It is in this position that we would reasonably expect to find any evidence of a vestigial one in the darters.

As already mentioned, the darter *Catonotis flabellaris flabellaris*

was selected for this study because the eggs of this form were easily obtainable. Sagittal and cross sections of the embryonic stages of this darter were made from the very early forms through many days post hatching. In a 3.5 mm. embryo (Plate LIX, Fig. 2 and Plate LXVI, Figs. 18 and 19) a distinct dorsal evagination occurs in the wall of the esophagus in the region of the second and third body somites, and slightly posterior to the heart. This corresponds in position to the origin of the air bladders in *Salmo salar, Carassius auratus,* and a little anterior to that of *Coregonus clupeaformis.* The diverticulum also corresponds in cellular structure with the preceding forms, being made up of a single layer of endodermal cells.

The diverticulum is still present twenty-four hours later in a 4 mm. embryo (Plate LIX, Fig. 3). Here, however, the area seems to be straightening out, and the evagination is being obliterated. Twenty-four hours later, at hatching, in a 4.75 mm. embryo (Plate LX, Fig. 4), there is no further evidence of it.

The relation of this diverticulum to the esophagus, the body somites, the region of the heart, and to the liver, and also its cellular structure, correspond very closely to the diverticula of the air bladders in *Salmo salar, Carassium auratus and Coregonus clupeaformis.* Therefore there is every reason to believe that this structure in *Catonotis flabellaris* is a rudimentary air bladder.

SUMMARY

The form and extent of the air bladder has a distinct bearing upon the shape of the kidneys in *Carassius auratus, Pomoxis annularis, Perca flavescens, Percina caprodes caprodes, Hadropterus maculatus,* and *Hadropterus phoxocephalus.* In *Carassius auratus,* where the bladder is constricted in the middle, a downward growth of the kidney occurs in this region. An increase in the diameter of the kidneys is also evident in *Percina caprodes caprodes, Hadropterus maculatus* and *Hadropterus phoxocephalus* anterior to the degenerate air bladder. In *Pomoxis annularis* and *Perca flavescens,* where the bladders are distributed evenly along the dorsal wall of the entire abdominal cavity, the kidneys are normal in their distribution.

Like the kidney, the extent of the length of the liver seems to

correspond with the presence and absence of the air bladder. The liver is more elongate in forms that have no air bladder.

The blood supply in the forms described as having an air bladder is similar.

An air bladder occurs in only two genera of darters, *Percina* and *Hadropterus*, and in these forms it is small and restricted to the posterior part of the abdominal cavity.

In *Coregonus clupeaformis* the air bladder originates as a dorsal evagination of the foregut anterior to the liver.

In *Carassius auratus* it also originates as a dorsal evagination of the foregut in the second and third body somites, and directly dorsal to the region of the heart.

In a 3.5 mm. embryo of *Catonotis flabellaris flabellaris* a similar diverticulum of the foregut occurs in the region of the second body somite corresponding in position to that in the forms already mentioned. This diverticulum is still present in a 4 mm. embryo but in a less marked degree. It is absent twenty-four hours later in a 4.75 mm. embryo.

From the structure of this diverticulum in *Catonotis flabellaris flabellaris*, and its relation to the foregut, body somites, and the region of the heart, there is every reason to believe that this structure is a rudimentary air bladder which very soon completely disappears.

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PLATE LIX

Fig. 1. Sagittal section through the alimentary canal of a 3 mm. embryo of *Catonotis flabellaris flabellaris,* 3 days before hatching. Magnification 80 ×.

Fig. 2. Sagittal section through the air bladder diverticulum of a 3.5 mm. embryo of *Catonotis flabellaris flabellaris,* 2 days before hatching. Magnification 80 ×.

Fig. 3. Sagittal section through the air bladder diverticulum of a 4 mm. embryo of *Catonotis flabellaris flabellaris* one day before hatching. Magnification 80 ×.

ABBREVIATIONS USED IN PLATES

A. H., Auricle
A., Air bladder
A. D., Air bladder diverticulum
AUD., Auditory vesicle
B., Brain
BC., Branchial clefts
BR., Branchial arches
C., Cerebellum
DA., Dorsal aorta
E., Eye
F., Foregut
G., Gonads
H., Heart
HG., Hind gut
I., Intestine
K., Kidney
L., Liver
MG., Midgut
M., Myotome
MA., Mandibular arch
N., Notochord
NC., Nerve cord
O., Oesophagus
P., Pharynx
PC., Pericardial cavity
PN., Pneumatic duct of the air bladder
PR., Pronephric tubule
S., Sinus venosus
ST., Stomach
V., Ventricle of the heart
VR., Vertebral column
X., Represents region where cross sections were made
Y., Yolk sac

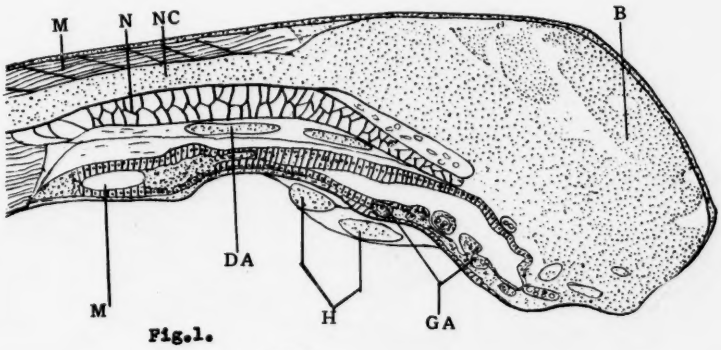


Fig.1.

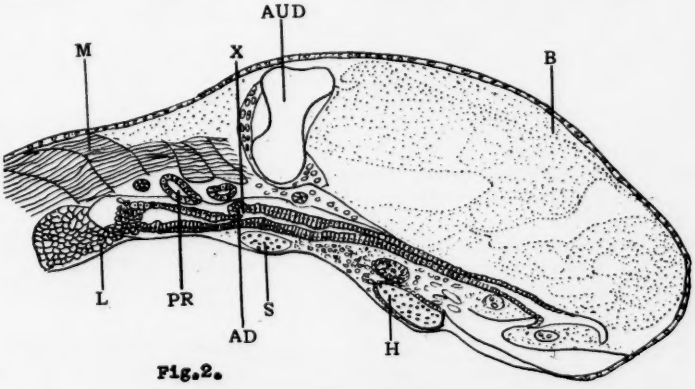


Fig.2.

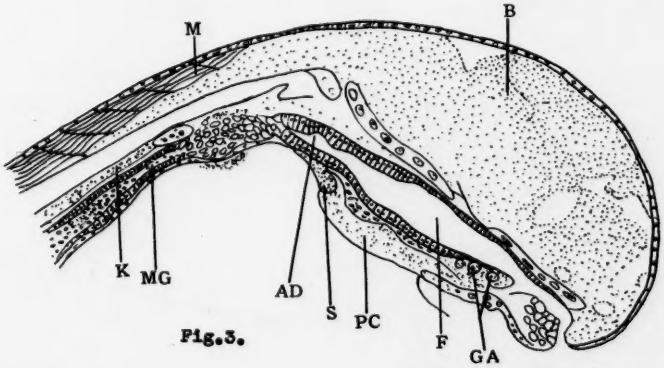


Fig.3.

PLATE LX

Fig. 4. Sagittal section through the alimentary canal of 4.75 mm. embryo of *Catonotis flabellaris flabellaris* one hour after hatching. Magnification 75.5 ×.

Fig. 5. Sagittal section through the air bladder, and the pneumatic duct of a 5.5 mm. embryo of the goldfish *Carassius auratus*. Magnification 62.2 ×.

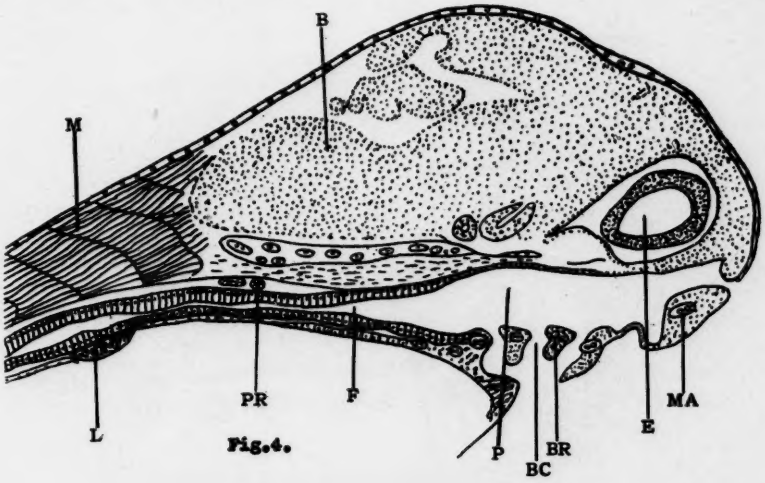


Fig.4.

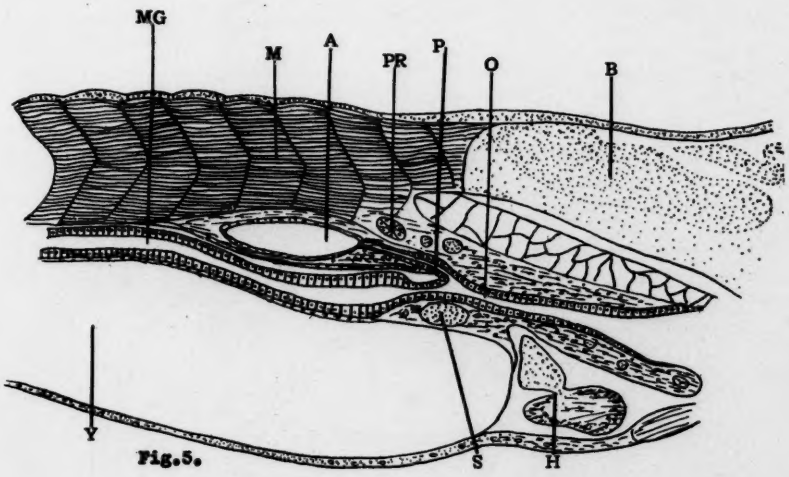


Fig.5.

PLATE LXI

Fig. 6. Sagittal section through the air bladder of a 28 mm. long *Carassius auratus*. Magnification 6.3 ×.

Fig. 7. Sagittal section through the air bladder diverticulum of a 10 mm. embryo of the white fish *Coregonus clupeaformis*, 11 days after hatching. Magnification 76.7 ×.

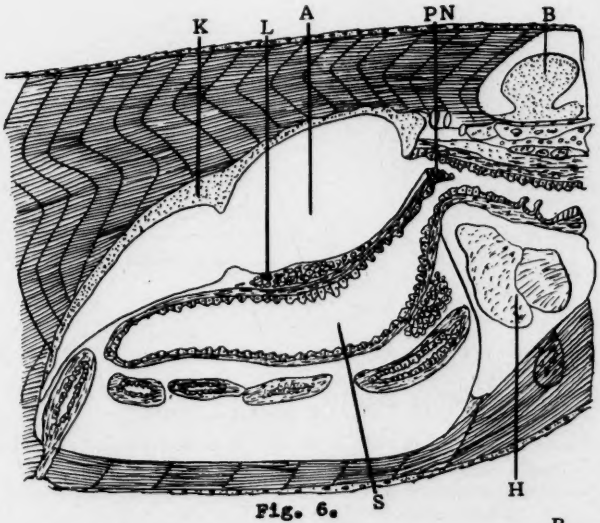


Fig. 6.

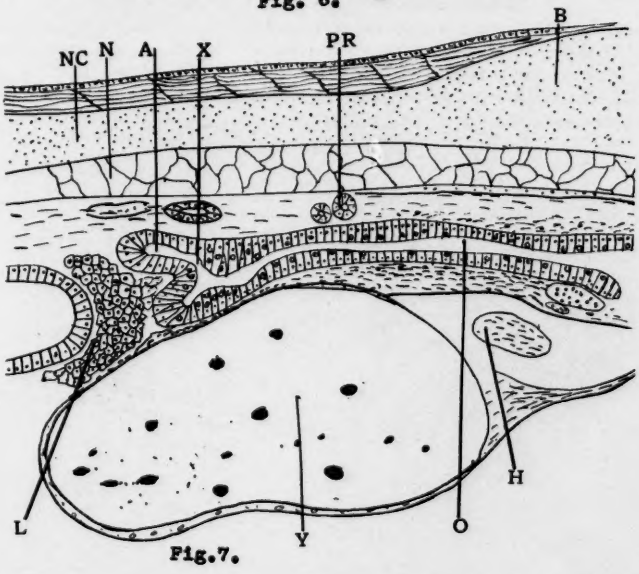


Fig.7.

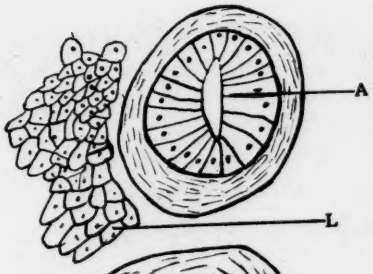
PLATE LXII

Fig. 8. Cross section through the air bladder diverticulum at × of Figure 7. Magnification 296.5 ×.

Fig. 9. Cross section through the air bladder diverticulum slightly posterior to × Figure 7. Magnification 295.5 ×.

Fig. 10. Sagittal section through the air bladder diverticulum of a 17 mm. embryo of *Salmo salar*. Taken from Hertwig's "Handbuch der vergleichenden und experimentallen Entwickelungslehren der Wirbeltiere."

Fig. 11. Sagittal section through the alimentary canal of a 23 mm. long *Catonotis flabellaris flabellaris*. Magnification 13.2 ×.



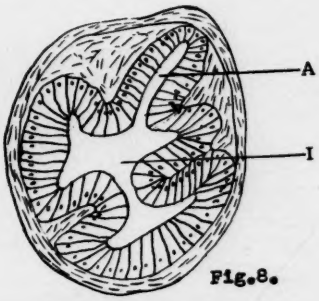


Fig.8.

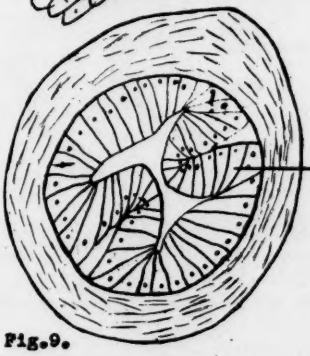


Fig.9.

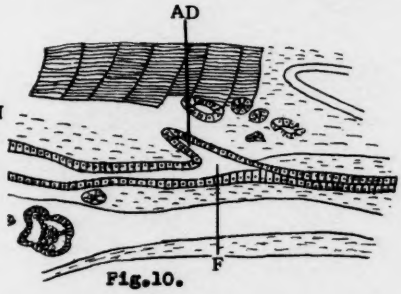


Fig.10.

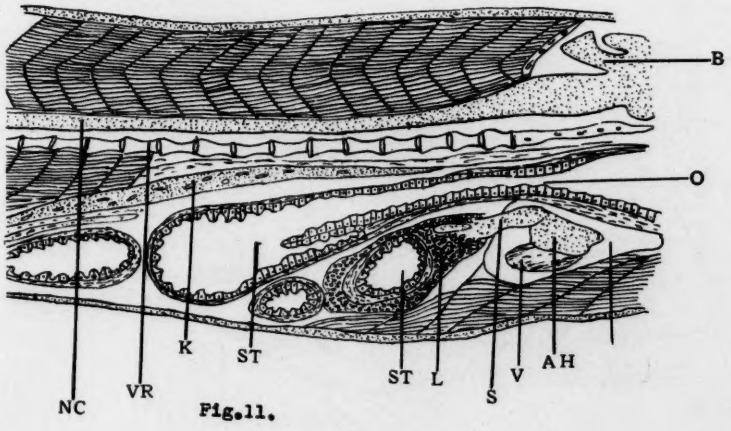


Fig.11.

PLATE LXIII

Fig. 12. Sagittal section through the alimentary canal of a 25 mm. long *Boleosoma nigrum nigrum*. Magnification 14 ×.

Fig. 13. Sagittal section through the air bladder of a 30 mm. long *Percina caprodes caprodes*. Magnification 14 ×.

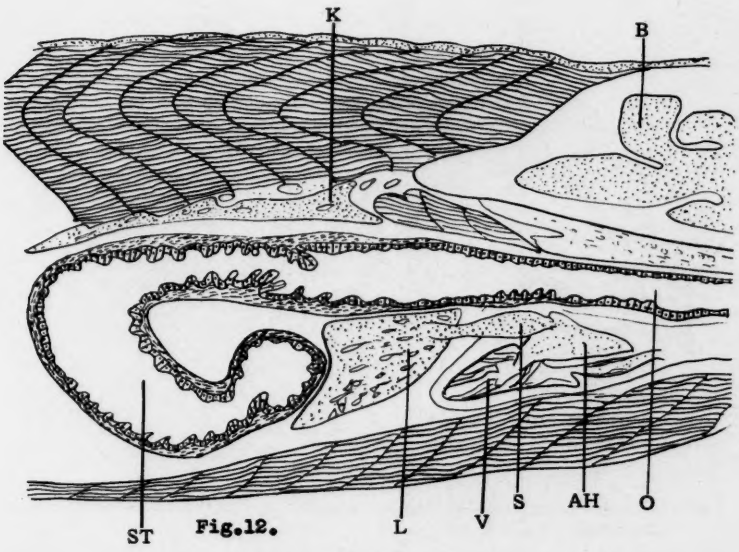


Fig.12.

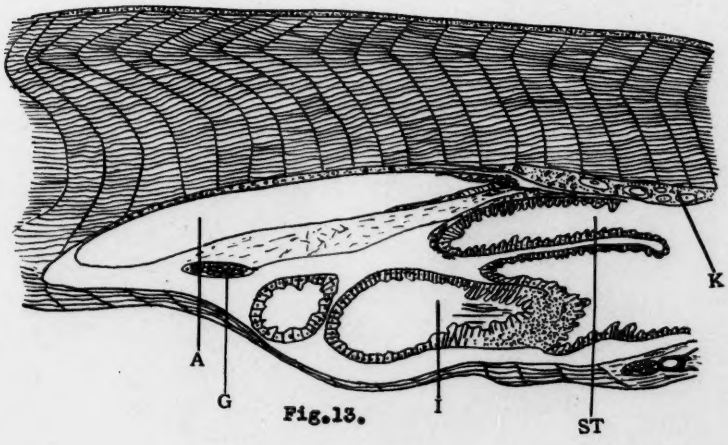


Fig.13.

PLATE LXIV

Fig. 14. Cross section through the air bladder of *Percina caprodes caprodes*. Magnification 13.7 ×.

Fig. 15. Cross section through the air bladder of *Hadropterus maculatus*. Magnification 17 ×.

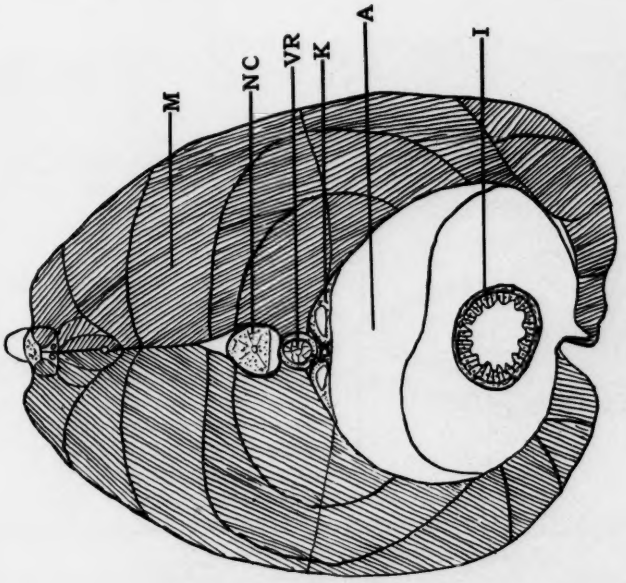


Fig.15.

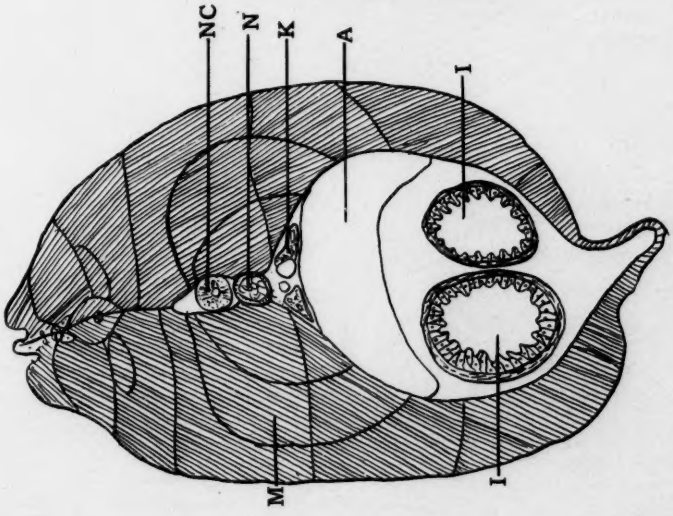


Fig.14.

PLATE LXV

Fig. 16. Sagittal section through the air bladder of a 32 mm. *Hadropterus maculatus*. Magnification 11.5 ×.

Fig. 17. Sagittal section through the air bladder of a 13 mm. long *Pomoxis annularis*. Magnification 14 ×.

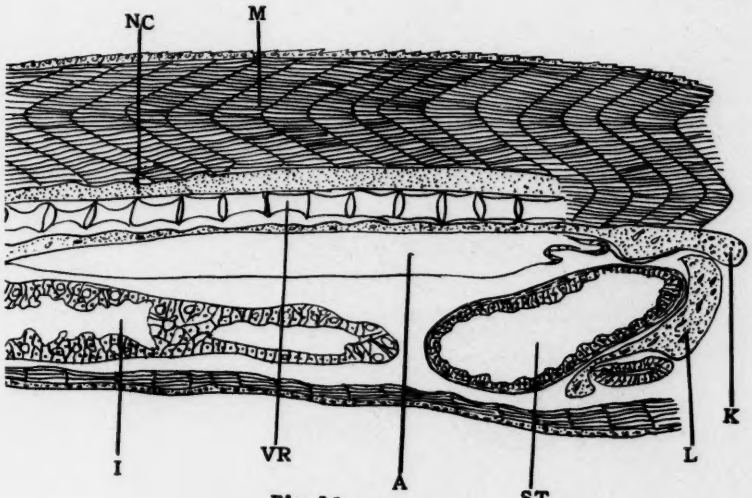


Fig.16.

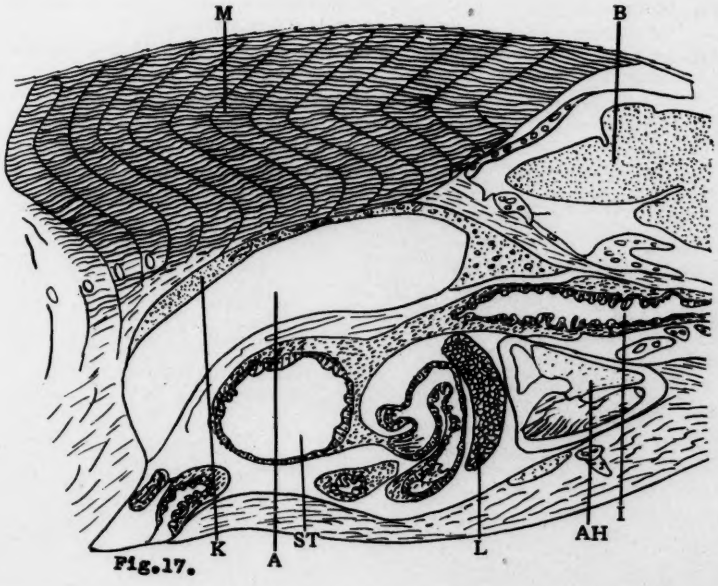


Fig.17.

PLATE LXVI

Fig. 18. Cross section through the air bladder diverticulum of a 3.5 mm. embryo of *Catonotis flabellaris flabellaris*. Magnification 81.8 ×.

Fig. 19. Cross section as in Figure 18 but slightly posterior. Magnification as above.

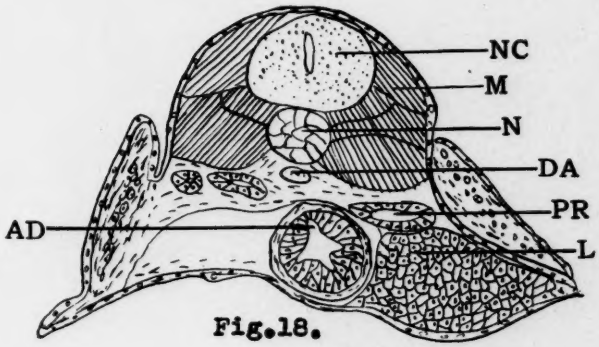


Fig.18.

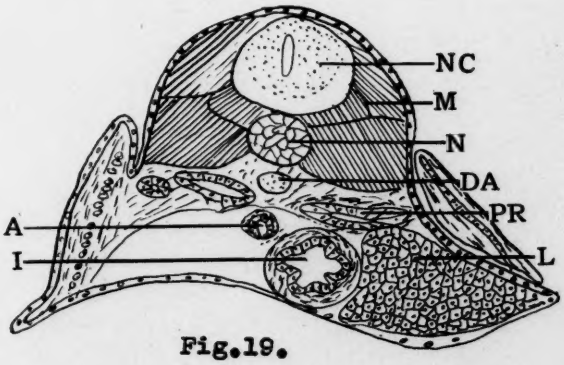


Fig.19.

PLATE LXVII

A photomicrograph of a sagittal section of the air bladder diverticulum of a 3.5 mm. embryo of *Catonotis flabellaris flabellaris*. Similar to Fig. 2, Plate LIX.

PLATE LXVIII

A photomicrograph of a sagittal section through the air bladder, and pneumatic duct of a 5.5 mm. embryo of the goldfish *Carassius auratus*. Similar to Fig. 5, Plate LX.

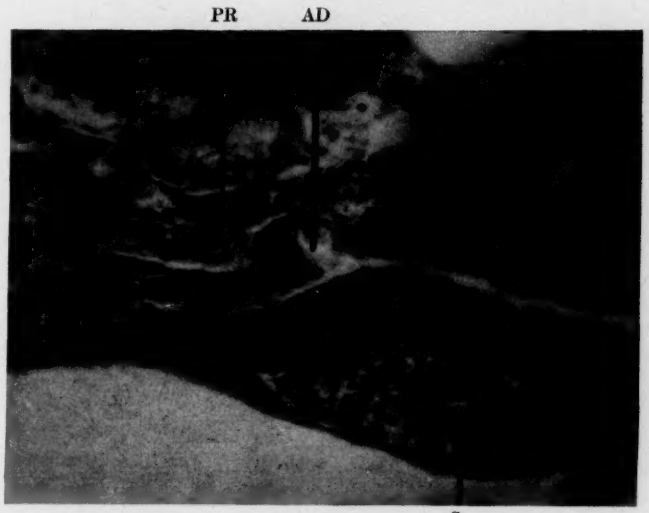


PLATE LXVII

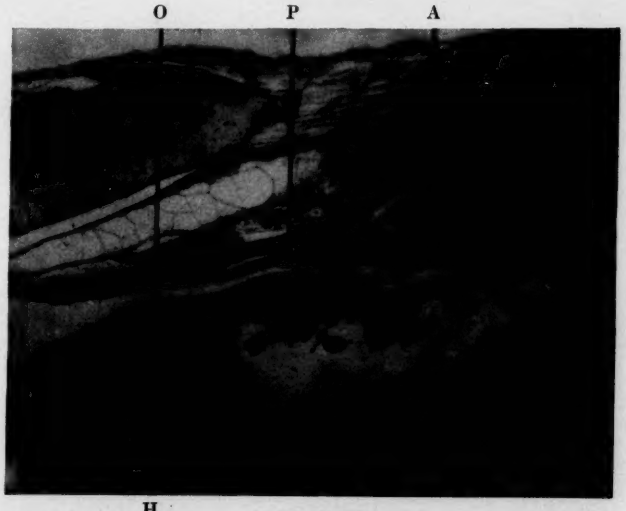


PLATE LXVIII

WE MUST SHAPE OUR NEW WORLD

ARTHUR HOLLY COMPTON*

Commencement Address, Denison University, June 15, 1936

Last June I was dining in Oxford with a leader of British education, and the question arose regarding the place of *science* in life. It has proved its value as a method for arriving at reliable knowledge, and for supplying us with certain necessities of life—but the inhumanness of it all! The discipline of thought inculcated by science was already embodied in Plato's mathematics. It seems that the predominant trend of modern science is toward replacing the human interests embodied in literature, art and music with technological developments in which the human factor becomes less and less significant. The most fundamental bases of morality and religion have been ruthlessly shaken, with the implication that their value is insignificant.

In Oxford, fortunately, there survives the tradition of emphasis on human values. Thus the Oxford don fears the dehumanizing influence of science, prefers a pen (though a fountain pen) to a typewriter, and would rather walk than ride behind a petrol motor. In India it is even possible for Gandhi to persuade his followers that the works of technology are harmful, and should be kept out of their lives. The American however cannot question the value of science and technology, for they are his very life! Railroads, automobiles, airplanes, agricultural machinery, mechanized meat packing, pasteurized milk; telephones, radios, movies; electric power—if these were gone we could not live. One might as well ask the farmer whether there is any value in planting crops! These things are the very basis of existence.

It was possible at an earlier stage of history for men to lose their interest in science because it had not proved its practical

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worth, and in philosophical thought the incomplete form of science led to difficulties which no longer appear to present themselves. Thus the Greek philosophers found that the science of Democritus failed to illumine their way of life. The religious leaders of Arabia saw science drawing its followers away from belief in Allah. Science can continue only as long as it supplies what men are wanting. In our civilization science is giving us the essentials of life. I can envisage nothing short of a world-wide catastrophe almost completely destroying mankind which could now do more than make a temporary pause in man's interest in science and technology. If this view is correct, the "mechanized world" which some already feel so oppressive is destined to be the world of the future.

But technology based on science has concentrated its attention upon finding more and better means of living—more abundant and more varied food, more comfortable homes, better clothing, faster means of transportation and of communication. The technical aspects of these problems are being rapidly solved. If all men do not enjoy the fruits of these efforts, it is not from any technological failure, but because of the unsatisfactory state of our social organization. The means of life are certainly improved. The great problem now facing civilized man is that of learning how to live in the civilization that he has built. This is a question for which our political and economic sages have done as little in finding an answer as have their technological brothers.

Back in the early 1920's I amused myself by making radio receiving sets. The first was a crystal set, and great was the thrill when it brought through the head-phones the faint but clear voice of a singer at the local broadcasting station. There came in succession one-tube, two-tube, and three-tube sets which brought in, though imperfectly, programs from the remote corners of the earth. The thrill of distance reception had been achieved. Then we found that the use of our radio rapidly fell off. Programs worth listening to were rare, and only too often a half-hour spent in turning the dial brought nothing more satisfying than an imperfect rendering of some threadbare jazz. The technique of the radio had been well developed, but the content of the radio

programs left much to be desired. Gradually as the broadcasting stations have made their offerings more significant, our radio has once more become interesting.

Similarly, it is the *content* of our lives that determines their value. If we limit ourselves to supplying the means of living, in what way have we placed ourselves above the cattle that graze the fields? Cattle can live in comfort. Their every need is amply supplied. Is it not when one exercises his reason, his love of beauty, his desire for friendship, his selection of the good from that which is not so good, that he earns the right to call himself a man? I should be inclined to claim that the person who limits his interests to the means of living without consideration of the content or meaning of his life, is defeating God's great purpose when he brought into existence a creature with the intelligence and god-like powers that are found in man. It is in living wisely and fully that one's soul grows. One of life's strange paradoxes is that those who spend great effort in securing the means of living are very apt to lose their appreciation of the values of life. "What shall it profit a man, if he gain the whole world, and lose his own soul?"

We are thus forcibly presented with the problem of the values of life. For a moment we may be satisfied with the fleeting pleasures of physical appetite and desire, or the excitement of keen competition, or the strife for preferment and fame. All of these have their essential place; but experience soon shows us that the search for such pleasures leads to disappointment if we meet with failure, and with disillusionment if we dwell too much upon what successes we may gain. Whence shall our more permanent satisfactions come? This may be considered the primary problem of religion. The answer which religion supplies sounds strange to modern ears: "Thou shalt love the Lord thy God with all thy heart, and thy neighbor as thyself."

For thousands of years men have tried many different ways of living, and have watched the consequences. The Philosophers of Greece, the Prophets of Israel, the Mystics of the Orient, the Libertines of later Rome, the Monastics of the Middle Ages, the Artistics of the Renaissance, the Puritans of the Colonial period—

the experiences of these and many others are passed down to us through the traditional morals that we have inherited. With our changing mode of life, much of this body of custom has become obsolete, and we find it necessary to develop new patterns of living suited to our new world.

Our leading thinkers are well aware of this vital need. There are those, however, who take the position that it is wholly unimportant as to what man does with his life. Man, they say, is merely the most intelligent of a large group of organisms, evolved by the automatic working of the natural laws of chemistry and evolution, that have infected the crust of one of the minor planets in a small galaxy. His actions are of significance to no one but himself and his fellow animals on this planet. What matter even if by mutual consent mankind destroy itself, as by a suicidal war? It would be merely the closing act of a side show that is of negligible importance compared with the rest of the great celestial circus.

If man is thus rated as insignificant, who is the judge that considers him of so little value? In his own eyes there can be no question but that man himself is of supreme importance. This idea may be considered as an aspect of self-preservation, and is fundamental to the welfare of the race. It is the firm foundation upon which the structure of humanism is built. Whatever we may assume regarding man's physical insignificance, or regarding his possible importance in the world scheme of an intelligent God, to man himself the welfare of man must be the highest objective. Biology, no less than religion, teaches that the man is good who will live, or if necessary die, for the advancement of mankind.

The great contribution of science to humanity is, it seems to me, the lesson of the need for knowledge of the truth and for the willingness to adjust our lives to this truth. Guided by the truths of physics and chemistry, the inventor and the engineer have freed us from much of slavery of physical drudgery. Medical science has given us longer lives and has gone far in freeing us from disease and pain. Seeing these successes of science as applied to other aspects of life, men willingly control their habits in accord with laws of hygiene, and a healthier world results. It

gradually becomes recognized that human relations are also subject to natural laws. These form the fundamental basis of morality. Since the days of Pythagoras it has been recognized that a world of law implies a life of self-discipline if that life is to reach its highest development. Thus in an era when many old conventions become outworn, the clear teaching of science is of special value: If a man will learn the truth and abide by it, that truth will make him free.

From the standpoint of evolution, all of our effort to learn the laws of nature and use them to our advantage is an aspect of an organism adapting itself to its environment. A species can thrive only in so far as its individuals are successful in making this adaptation. Biologically speaking the good man is he who has well adapted himself; he is also the one who will presumably find life most worth living.

We may accordingly consider the firm foundation of humanism to be the essential principles of biology. He who strives for the welfare of the species shows thereby his adaptation to his environment, and he is a human asset. The obverse of the picture is that if one does not so strive, he becomes ill-adapted to his environment, and humanity, as a part of nature, must become his enemy. For man himself the welfare of man must be the ultimate goal.

This is point *A*, derivable equally from biology, philosophy, or religion: *The only adequate objective of man's life is the welfare of man.* Point *B* of the present discussion is that *this audience—and especially this graduating class—have a distinctive responsibility and opportunity to further man's welfare.*

Is it not probable that man's view of his own importance is a highly distorted one? If we could obtain a truly cosmological view of ourselves would we not be found quite insignificant? One can see in this question the focus of the great controversies between religion and science. Galileo's confirmation of the heliocentric theory of Copernicus, and Darwin's reminder that man is to be considered only as a particular species of animal, characterized by unusual mental development, both pointed away from religion's homocentric view of a world whose chief end is man.

If we are to find any more ultimate basis of man's value, than his own judgment, we must refer to some intelligence superior to man; for if we suppose mankind to be the only intelligent being, his judgment of value is necessarily final. Of how great import may we reasonably assume an intelligent God of the Universe to consider man?

I recently visited a great grain elevator in company with the engineer responsible for its design and construction. Heavy freight cars were picked up as toys, and tipped on end to pour out their loads of wheat onto the rapidly moving conveyor belts. Powerful machines winnowed and cleaned the grain and sorted it into the appropriate bins. Other conveyors carried the wheat to a long series of loading spouts, where it was poured into the hold of a ship waiting to carry the precious cargo across the ocean. Where was the important thing in this great structure? Was it the mighty mass of steel and concrete, covering acres of ground and rising hundreds of feet into the sky? Was it the powerful motors that handled the cars and carried the grain where it was wanted? Of what value would these be were it not for my companion whose constructive thought it represented, and who was now checking it over to be sure the great system functioned as was planned? A lifeless mass of stone and steel were it not for the handful of men whose will it obeyed!

Or again, is a house of greater value to its owner than the family it protects?

For the importance of anything depends upon the interests of the one who judges. Is man of less significance than the stars? Ask a mother if she would trade her newborn babe for the brightest star in the heavens. Even to the astronomers, if the child happens to be a Newton, he would be worth many galaxies of stars. Who then is to say that man is an object of indifference to God? Is it not reasonable to suppose that to an intelligent Creator intelligent creatures may be of especial interest?

In considering this question, we may well inquire whether the intelligent life that we find on our planet is distinctive, or whether there may be something like it on millions of other planets distributed throughout the universe. The best opinion which

science is able to offer has been summarized by Eddington in his book "The Nature of the Physical World" in this statement:

> "I do not think that the whole purpose of Creation has been staked on the one planet where we live; and in the long run we cannot deem ourselves the only race that has been or will be gifted with the mystery of consciousness. But I feel inclined to claim that at the present time our race is supreme; and not one of the profusion of stars in their myriad clusters looks down on scenes comparable to those which are passing beneath the rays of the sun."

Some astronomers would not agree with this view but feel that conditions like those on the earth are much more common. I am myself persuaded of the essential truth of Eddington's conclusion.

We need not think that if human life fails to achieve its great goal on earth that it is nature's last chance. Yet in all probability, within our universe such chances are quite limited in number. The position might be taken that this rarity of life means that life is of minor consequence in nature's scheme. One might as well argue from the fact that only one maple seed in a million grows to a great tree in the forest, that the growth of trees is only a minor interest in the life of the maple seed. Just as truly as the maple seed will sprout and grow where the conditions are right, so our knowledge of the earth and Mars suggests that wherever a planet exists under the right conditions, life will appear.

Some years ago I visited Sequoia National Park, and saw there a group of giant redwoods. Among them was one known as "General Sherman," said to be the largest tree in the world, and a group of some hundreds of lesser giants, each of which has been growing for thousands of years. Each tree is a monument that it would require an age to replace, and our government has rightly chosen to spare them from the woodman's axe. If by some disaster one tree is destroyed, nature has yet others which may develop to their full majesty. But the number of trees is limited, and to those who love the trees it is of vital interest that each healthy one which has a promising location be given a full opportunity to grow.

Is not the life of man on earth similar to that of one of these great trees? No doubt there are or will be other places where

similar or perhaps higher types of life may be developed. But there is reason to believe that we may occupy at present the highest position in the universe with respect to intelligent life. Does it seem then too bold to assume that the intelligent Creator, whose existence seems by far the most reasonable basis for accounting for our world, should take an active interest in the welfare of the perhaps uniquely intelligent beings he has created on our earth? The remarkable course of evolution, leading as it has against tremendous odds to organisms with the modicum of intelligence that we possess, really seems to point in that direction.

From the observed uniformity and universal applicability of nature's laws, it would be quite unreasonable to suppose that the world plays favorites by showing partiality toward man. Rather we find that the laws of nature are such that, under the conditions existing on earth, a group of living organisms, of which man stands foremost in intellectual development, evolve as a matter of course. As a part of this evolution, his physical adaptability and reasoning powers have undoubtedly arisen through the strict working of natural law. According to this law hardships have had to be surmounted. In the age-long struggle with other animals, cunning and craft have developed. To gain needed shelter and food, inventiveness has been at a premium. In order to live in satisfactory relations with other men, a conscience has evolved. At each stage, however, there has been tragic, apparently ruthless, suffering. This has been nature's method of forcing slowly developing humanity to search for and follow the better way. It would be hard to imagine a process for achieving adaptation to environment that would be more certainly effective than the one we see now working in nature. With regard to our distinctively human characteristics, however, we are clearly in the early stages of evolution. It would be a gross understatement to claim that with respect to such attributes as clarity of reason, appreciation of beauty, or consideration of our fellows, our remote descendants may be expected to excel us as greatly as we are in advance of the Java ape-man.

Nevertheless, whatever may be the method employed, the result has been that when we learn nature's laws and school

ourselves to obey them, we can turn them to our advantage. That is, these laws are friendly to a well-adapted organism. Is nature friendly to us? Assuredly, if we will learn her laws and adapt our lives accordingly. If we do not, she becomes our merciless enemy. Such is the stern yet kindly dictum which science has to offer.

Here, however, is the point of first importance: We find that we are able to adapt our environment to our needs. In fact, we are masters of the plant and animal life on the earth, and have in our hands the means of controlling to a large extent even the direction of our own evolution. Up to the dawn of social conscience, which Mr. Breasted, in his recent book, "The Dawn of Conscience," placed at about four thousand years ago, God held in His own hands the whole responsibility for evolution of life upon this planet. Gradually this responsibility is being shifted to our shoulders. As science advances, it seems inevitable that this transfer of authority will approach completeness. Considering the many obvious errors that we are making we may be thankful that we do not yet have complete control. Yet who can fail to respond to the opportunity and challenge that are before us of working with the God of the Universe in carrying through the final stages of making this a suitable world and ourselves a suitable race for what is perhaps the supreme position of intelligent life in his world!

Let us assume then, that whether from biological necessity, from humanistic motives, or inspired by the opportunity to share in God's great program, we desire to take a part in shaping our new world for the betterment of man. Are we in a position to do anything?

If men are to reach a satisfying life as masters of machines, it cannot be by fighting against a "brave new world" that is thrust upon them, but by finding themselves a part of this world and adapting their lives to it. Those on whom this world merely thrusts itself with irritating frequency may retreat behind walls of tradition and consider academically what adjustments should be made. Those, however, who are a part of the mechanized world must adapt themselves to it or perish. Clearly it is toward

the mechanized communities that we must look to find the most rapid adaptation of our thought and customs.

For this very fundamental reason, the educational institutions in our mechanized America are those toward which men look for leadership in meeting the spiritual as well as the more mundane problems of life in the changing world. Here are communities of scholars schooled in the scientific method. In Oxford, with its "classics" and "modern greats," science plays a minor rôle. In my University at Chicago, three of the four great divisions of the University are sciences; physical, biological, and social, and even in the humanities the scientific approach is close to the surface. At the same time, with four affiliated theological schools, a great Oriental Institute for studying man's growth through the ages, and extensive development in art, we find a conscious effort being made to discover how those things of tested worth can be incorporated into our modern society. I do not mean that this effort is confined to our University. If the severity of the demands of mechanized life are not felt quite so strongly along the Atlantic coast, the great educational institutions there located have the advantage of a closer contact with Europe, whose traditions must serve as a most valuable guide. All of our educational leaders are striving to find and develop the true values present in the new world. However, this search is necessarily most urgent and the changes most rapid where science and technology are most essential to life.

Of the world's vast multitudes it is thus those whose civilization is based upon science and technology who seem to hold the keys to the future. We find ourselves in the very center of that civilization. Of this limited part of humanity, it is the educated group who are in a position to understand what is going on. Only those educated men and women, however, who will concern themselves with the more fundamental values of life can act as leaders in shaping the new world.

I do not want to be sensational; but if we follow the thought that we have been developing to a reasoned conclusion, we are led to see that a surprisingly large share of the responsibility for carry-

ing through a major program of the God of the Universe rests upon the shoulders of those present in this audience.

Even though one may hesitate to accept so bold a view, the conclusion is inescapable that we have here in the mid-west an opportunity that is perhaps unparalleled for finding and developing the distinctive human values of the new civilization. To make these values evident will require all of the science, education and religion of our community. We form a natural world focus, and if we can point the way to higher human values, the new world will follow our leadership.

Science has thus helped us to appreciate the inspiring setting in which we find ourselves. We recognize the greatness of the program of nature which is unfolding before us, and feel that we are a vital part of a great enterprise in which a mighty Intelligence is working out His hidden plan. In our hands we hold the control of the conditions of life on this planet. If indeed the creation of intelligent persons is a major objective of the Creator of the Universe, and if, as we have reason to surmise, mankind is now His highest development in this direction, the opportunity and responsibility of working as God's partners in his great task are almost overwhelming. What nobler ambition can one have than to cooperate with his Maker in bringing about a better world in which to live?

To Milton, the best for which man could hope was a return to a Golden Age of life like that in Paradise before the Fall. With the perspective of science, we now see ahead of us the possibility of attaining heights of development far above those of the past and the present. We are thus presented with a new hope. Loyalty to our Maker, who has given us the ability, opportunity, and responsibility to mold our lives and our world according to a more perfect pattern, cannot but inspire us to work with him heart and soul toward this great end.

LATER HISTORY OF THE JOURNAL OF THE SCIENTIFIC LABORATORIES OF DENISON UNIVERSITY, 1908–1935

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Received November 11, 1936; published February 22, 1937

The history of Denison's official scientific publication from its first volume in December, 1885, through the thirteenth volume, completed in September, 1907, has been ably recounted by August F. Foerste (*1*). It is the purpose of this article to continue the historical acount through the remaining years of the first half-century of the life of this unique journal to December, 1935.

In November, 1908, Denison University was host to the Ohio Academy of Science, which held its Eighteenth Annual Meeting in Granville at that time. In welcoming the Academy, President Emory W. Hunt expressed not only his own personal philosophy concerning scientific research but also that of at least the majority of the Denison trustees when he said, "The teacher needs also the side-lights upon truth, the special illumination and inspiration, the enrichment of his own life, which come only from original research and independent investigation. . . . One who is mentally alive enough to teach, will inevitably be extending his lines of inquiry into new territory. If he does not do this, his own mental life will stagnate and he will lose teaching power."

That a Baptist minister and the Trustees of a Baptist college should have had such an attitude toward the function of research in an educational institution is not so surprising as the fact that those responsible for the financial administration of such a college should have appropriated funds for the support of research and for the publication of its results year after year, despite the almost insurmountable difficulties of balancing the budget, and even during many a fiscal year which closed with a deficit on the treasurer's books. But such indeed is the record. The "new

lease on life" which Dr. Foerste notes (*2*) as having been secured by the Bulletin "with the publication of volume 14" was a result of the under writing by the University of the cost of publishing a journal which had previously been largely financed from the personal funds of its editors and contributors. Annual subsidies from the University have continued with rarely broken regularity from the days of President Hunt's administration to the present time.

The effect of this support is immediately apparent to anyone who compares the format, typography and illustrations of the later volumes with those of the first thirteen volumes of the Bulletin. In appearance, the Denison scientific journal takes its place of honor among the best of the learned periodicals of the world. It is significant also that whereas during the 23 years between 1885 and 1908 the thirteen volumes which were issued totaled 1746 pages, during the 27 years from 1908 through 1935 a total of 5395 pages were published in 17 volumes.

Five of these volumes were edited by Dr. Frank Carney, who was responsible for the destiny of the Bulletin from November, 1908, to December, 1916. Dr. Carney had come to Denison in 1904 as Professor of Geology, and during the next thirteen years his department became famous, not only within the University but throughout the entire nation, for the excellence of its instruction and for the ability of its graduates. Not the least of his contributions to science and education, however, was that resulting from his labors on behalf of the Bulletin.

Frank Carney was born at Watkins, New York, March 15, 1868, and while a pupil in the district school decided to make teaching his life work. In 1891 he entered Cornell University, and after three years of study there returned as principal to Starkey Seminary where he had previously been a student and later an instructor in mathematics and history. By attending summer sessions he completed his course at Cornell, where he received the A.B. degree, and then continued his graduate studies to receive the degree of Ph.D. in 1909.

Volume 14 of the Bulletin, the first to appear under Dr. Carney's editorship, consisted of 18 articles, published in four

parts, between November, 1908, and November, 1909. The first of these four parts contained four papers by the editor himself (he consistently signed his name "F. Carney" in those days), two of which, "Pre-Wisconsin Drift in the Finger Lake Region of New York" and "Wave-cut Terraces in Keuka Valley, Older than the Recession Stage of Wisconsin Ice," dealt with field work presented in connection with his studies at Cornell. Another, only six pages in length, entitled "State Geological Surveys and Practical Geography," reveals Dr. Carney's budding interest in geography as an appropriate field for scientific study and collegiate instruction, an interest that was later to flower in numerous geographical papers and in the expansion of the Denison curriculum to include several pioneer courses in geography. There was also a description of an esker group south of Dayton, Ohio, by Earl R. Scheffel, a graduate student in geology who was Dr. Carney's assistant while preparing for an M.S. degree.

Part 2 of volume 14 included likewise five articles and appeared in April, 1909. It contained a description of "Fossils from the Silurian formations of Tennessee, Indiana and Kentucky," by August F. Foerste, about whom more will be written later; another paper, "A Stratigraphical Study of Mary Ann Township, Licking County, Ohio," by Dr. Carney; and the last of Earl Scheffel's contributions to the Denison Bulletin, entitled "Significance of Drainage Changes near Granville, Ohio." There was also a report of studies on babbitt and other alloys by Jesse A. Baker, a graduate student and assistant in the Department of Chemistry, and a paper on "The Age of the Licking Narrows" by Kirtley F. Mather, then in his senior year as an undergraduate at Denison and serving as a laboratory assistant to Dr. Carney.

The third part of volume 14, published in June, 1909, contained an unusually wide assortment of scientific studies. There was a description of a spectrometer for electromagnetic radiation by A. D. Cole, formerly professor of physics in Denison, at that time professor of physics in Ohio State University, and for many years a member of Denison's Board of Trustees; another paleontological contribution from August F. Foerste; two geological papers by Dr. Carney; and an important study concerning the

development of the embryo of Diemyctylus by George E. Coghill. Dr. Coghill, a graduate of Brown University in 1896, had been associated with C. L. Herrick at the University of New Mexico between 1897 and 1900, and had come to Denison from Willamette University in Oregon, to succeed C. J. Herrick as professor of zoology, in 1907. He left Denison in 1913 to join the faculty of the University of Kansas and is now a member of the Wistar Institute in Philadelphia. Since 1927 he has been managing editor of the Journal of Comparative Neurology, founded at Denison in 1891 by C. L. Herrick (*3*). Denison conferred upon him the honorary degree of Doctor of Science in 1933.

Volume 14 was completed in November, 1909, by the publication of two articles. One of these consisted of "Preliminary Notes on Cincinnatian and Lexington Fossils" by August F. Foerste. The other was Dr. Carney's doctoral dissertation, "The Pleistocene Geology of the Moravia Quadrangle, New York," submitted to Cornell University in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

The year 1910 marked the twenty-fifth anniversary of the election of Clarence Luther Herrick to the Professorship of Geology and Natural History at Denison University. In 1885 Dr. Herrick began publishing the Bulletin of the Scientific Laboratories, and in 1887 founded the Denison Scientific Association. The Bulletin became the official publication of the Association, and has continued for fifty years as the exponent of the scientific life of the college. To commemorate this anniversary, volume 15 of the Bulletin was issued as a single number containing 100 pages of "Philosophical and Psychological Fragments by the late C. L. Herrick" assembled under the general title, "The Metaphysics of a Naturalist." The material had been compiled from a large collection of miscellaneous papers, mostly unpublished manuscripts and notes, shortly after Professor Herrick's death in 1904. The greater part of this compilation was done by H. Heath Bawden, who had studied under Professor Herrick in the early nineties, and received the degrees of A.B. and A.M. from Denison in 1893 and 1894. Dr. Bawden later obtained the degree of Ph.D. from the University of Chicago, and subsequently taught phi-

losophy and psychology at the University of Iowa, at Vassar College and at the University of Cincinnati. The entire manuscript of the Herrick Memorial Volume was further edited by George Fitch McKibben, most of whose long and fruitful life as a teacher of romance languages was spent as a member of the Denison faculty.

The sixteenth volume of the Bulletin was published in four parts, in June and December, 1910, and April and July, 1911. In it were assembled seventeen articles covering a considerable range of scientific topics, with notable concentration in geology. There was another scholarly paper by August F. Foerste, "Preliminary Notes on Cincinnatian and Lexington Fossils of Ohio, Indiana, Kentucky, and Tennessee," and a half-dozen "Chapters on the Geography of Ohio" by Dr. Carney. There were also the first two of a series of articles on "The Abandoned Shorelines of the Glacial Lakes in Northern Ohio," a result of field studies carried out by Dr. Carney under the auspices of the Geological Survey of Ohio between 1908 and 1916.

Additional papers on geology included a study of "The Mercer Limestone and its associated Rocks in the Newark-Zanesville Region" by Clara Gould Mark, a graduate student at Ohio State University. This was Miss Mark's thesis submitted in fulfillment of the requirements for the degree of Master of Arts at Ohio State, and was doubtless published in the Denison bulletin because it dealt with a local problem, even though she was not connected with Denison. The list of geological papers in this volume was completed by a description of "A Case of pre-glacial Stream Diversion near St. Louisville, Ohio," by Howard Clark, who at the time of making that study was an undergraduate student at Denison. He later served for many years as a member of the U. S. Geological Survey and was subsequently associated with Dr. Carney in commercial work as a petroleum geologist.

The other sciences represented in volume 16 were chemistry, physics, botany and astronomy. Miss Lily Bell Sefton contributed to the issue of December, 1910, a paper on "Standardization of Well Water in the Vicinity of Granville" in which she reported the results of work done under the direction of Arthur M.

Brumback, professor of chemistry in Denison from 1905 until his death in 1916. Miss Sefton graduated from Denison in 1911 and served as assistant professor of Chemistry from then until 1918. In 1921 she received the degree of Ph.D. from Ohio State University, and since that year she has been a member of the department of chemistry in West Virginia University, where she married one of her colleagues, Dr. E. P. Deatrick.

Physics was represented by Albert W. Davison who contributed a paper on "Thermo-electric Couples" (April, 1911). This was a thesis for which the Fletcher O. Marsh Prize in Physics was awarded at the time of the author's graduation from Denison in 1910. The next year he earned a Master's degree at Ohio State, and in 1914 he received the degree of Ph.D. from Cornell. Since 1921, Dr. Davison has been professor of physical chemistry in Rensselaer Polytechnic Institute at Troy, New York, where for many years he has served as head of the department of chemical engineering. The botanical paper was a "Study of the Supposed Hybrid of the Black and Shingle Oaks," which had been submitted in fulfillment of the requirements for the degree of Master of Science by Earl H. Foote in 1910. Its author had graduated from Denison in 1909 and was assistant to Professor Malcolm E. Stickney while pursuing his studies in botany toward the higher degree.

The special feature of the July, 1911, issue was the dedication of the Swasey Observatory, which occurred on June 15, 1910. On that occasion Denison had conferred the honorary degree of Doctor of Science upon Ambrose Swasey, the donor, and addresses had been delivered by John A. Brashear, Director of the Allegheny Observatory, and Edwin B. Frost, Director of the Yerkes Observatory. To provide a permanent record of this significant event in the history of Denison, the Bulletin printed a description of the new observatory, written by Herbert C. Wilson, at that time director of the Goodsell Observatory of Carleton College, and the address entitled "The Contribution of Astronomy to General Culture," which had been delivered by Dr. Frost.

Like the preceding volume, the seventeenth was also issued in four parts and contained a great preponderance of geological

papers. There were three long contributions to Paleozoic paleontology from the pen of Dr. Foerste, one issued in March, 1912, another in March, 1914 and the third in September, 1914. There were two more of Dr. Carney's "Chapters on the Geography of Ohio," and the third of his series of papers dealing with the shorelines of glacial lakes in northern Ohio, as well as several contributions to geology and geography by the young men and women who were studying under his direction.

Among the last-mentioned group was a "Geographic Interpretation of Cincinnati, Ohio" (March, 1912), prepared by Edith M. Southall as an assignment in one of Dr. Carney's advanced courses in geography, which by that time had been recognized in Denison, as elsewhere, as an appropriate subject for a university curriculum, although even then few colleges or universities had admitted it to that status. Miss Southall graduated from Denison in 1913, married Frank L. Fleener, Denison, 1912, and for a time was employed by the Kansas Geological Survey in a secretarial capacity.

During 1912–13 Dr. Carney had leave of absence from Denison to serve as acting professor of geology in the University of Michigan. As evidence that he spread the same gospel in Ann Arbor as in Granville, we find in the March, 1914, issue of the Denison Bulletin, a paper entitled "Geographic Factors in the Establishing of the Ohio-Michigan Boundary Line," which had been prepared by Constance G. Eirich in connection with one of his courses there. Still another student thesis in geography was included in this volume. It was a "Study of the Influence of Glaciation on Agriculture in Ohio" (September, 1914), by Edgar W. Owen, who graduated from Denison in 1915, received the degree of Master of Arts from the University of Missouri in 1916, and after a term of employment as a petroleum geologist in commercial work returned to Denison for another year of graduate study in 1919-20, since which time he has continued his career in petroleum geology.

There were also two papers in this volume by Denison undergraduates majoring in geology. One was a joint paper on "Drainage Changes in the Moots Run Area, Licking County, Ohio" (March, 1913), by Harmon A. Nixon, Denison, 1911, and Dexter

J. Tight, Denison, 1912, in which were reported the results of a field investigation carried on under Dr. Carney's direction as a part of an advanced seminar. Dexter Tight remained in Denison after his graduation to serve as graduate assistant in geology and complete the requirements for a Master's degree. He was the son of W. G. Tight, who had been associated with C. L. Herrick in the earlier years of the Denison Scientific Association and had contributed several papers to the earlier volumes of the bulletin (*1*). He is now in business in California, in employment which permits him to make good use of his scientific training. The second of these two papers was a brief description of an esker at Locust Grove, Ohio, by James D. Thompson, Jr., which was included in the September, 1914, issue. Thompson graduated in 1914, and has since been engaged in commercial work as a petroleum geologist.

In addition to these papers dealing with geological and geographical subjects, volume 17 contained two contributions in engineering and mathematics. Theodore S. Johnson, Denison, 1908, at that time professor of engineering, contributed a "Comparative Study of Circular and Rectangular Imhoff Tanks." The mathematical paper was prepared at the University of Chicago by Forbes B. Wiley and Gilbert A. Bliss. Dr. Wiley had been instructor and assistant professor of mathematics in Denison from 1910 through 1912 and had then gone to Chicago to complete his studies for the doctorate, which he received in 1914. Since then he has been professor of mathematics in Denison.

A special feature of this volume was the celebration of the twenty-fifth anniversary of the founding of the Denison Scientific Association. In the March, 1913, issue is a record of the commemoration meeting which had been held April 12, 1912, and the address entitled "The Foundations of Culture" which was delivered by C. Judson Herrick at special public exercises on April 16, 1912.

The first number of volume 18 appeared in December, 1915. It contains the proceedings of the inauguration of Clark W. Chamberlain as President of Denison University, a post which he occupied from 1913 to 1927. Supplementing the record of the

ceremonies and the addresses of that historic occasion is a succinct account of Denison University Presidents by William H. Johnson, professor of latin and secretary of the Alumni Society for many years. This issue also contains the doctoral dissertation of Kirtley F. Mather, who had continued his geological studies at the University of Chicago, after graduating from Denison in 1909, and had received the degree of Ph.D. there in June, 1915. It is a study in later Paleozoic paleontology entitled "The Fauna of the Morrow Group of Arkansas and Oklahoma."

The second part of volume 18 contained four articles and was published in December, 1916. Dr. Foerste contributed another of his studies of Cincinnatian fossils and Dr. Carney published two additional reports on the shorelines of the glacial lakes in the Lake Erie basin, as well as an address on the progress of geology during the period 1891–1915, which he had delivered at the celebration of the Quarter Centennial of the Ohio Academy of Science.

There followed an interval of more than two years before the next publication of the Denison Scientific Bulletin. This was the longest hiatus in the steady output of scientific papers in this medium since its establishment in 1885. Dr. Carney resigned from the Denison faculty in the spring of 1917 to enter commercial work in petroleum geology and the Scientific Association was without a permanent secretary, the main function of whose office had been traditionally the editing of the Bulletin. At the same time the entrance of the United States into the World War completely disrupted the procedures of most institutions of higher learning, and in Denison as elsewhere the customary routine of scientific research was temporarily abandoned.

When Dr. Carney left Denison he accepted the position of chief geologist in charge of the geological and land departments of the National Refining Company, a post which he occupied with distinction until 1928. Despite his success in the practical application of his scientific knowledge to the important task of developing the fuel resources of our country, he could not resist the attraction of his first love, teaching, and in the fall of 1928 he returned to the halls of Academe. During that college year he taught geography in Texas Christian University, and in the fall of 1929 he

became head of the Department of Geology and Geography in Baylor University, Waco, Texas. Here he was beginning to duplicate the success which had crowned his years at Denison, when he died on December 13, 1934. Although Frank Carney's greatest contribution to the world is the spiritual and intellectual heritage which he bestowed upon hundreds of students during his life as a teacher, among the tangible products of his career as a scientist none exceeds in value the five volumes of the Bulletin of the Scientific Laboratories of Denison University upon the title-pages of which appears his name as editor.

The next two volumes of the Bulletin were edited by Kirtley F. Mather, who was appointed professor of geology in Denison University in the spring of 1918. Reference has already been made to his undergraduate work at Denison and to his doctoral dissertation. Here it is appropriate to add a few brief biographical statements. Born in Chicago, February 13, 1888, Kirtley Mather's attention was first directed toward earth science by Mrs. Jane Perry Cook, a teacher of physiography in the South Chicago High School, now the Bowen High School, from which he graduated in 1904. He then entered the University of Chicago and soon came under the influence of Professors Wallace W. Atwood and Rollin D. Salisbury in the department of geology. When, therefore, he transferred to Denison in the fall of 1907, he was already committed to geology as his life work and had made considerable progress in his training along geological lines. It was consequently not surprising that he promptly became one of Dr. Carney's most devoted students and soon was serving as student assistant in geology.

After receiving the degree of Bachelor of Science from Denison in 1909, Kirtley Mather returned to Chicago for two years of graduate study. Here he was under the stimulating influence of Professor T. C. Chamberlin, at that time the "dean" of American geologists, and became Dr. Atwood's associate in an ambitious program of research concerning the glacial geology and physiography of the San Juan Mountains in Colorado. Field work in that region, under the auspices of the U. S. Geological Survey, occupied eight summers between 1910 and 1922 and finally re-

sulted in the publication of U. S. Geological Survey Professional Paper No. 166 in 1932.

Following those two years at Chicago, Kirtley Mather was appointed instructor in geology in the University of Arkansas where he taught from 1911 to 1914, before returning to Chicago for his final year of graduate work. While in Arkansas he collected the fossils from the Morrow formations which served as the material on which his doctoral dissertation was based. This paleontological research was prosecuted under the direction of Dr. Stuart Weller, and the type specimens of the many new species in the Morrow fauna were deposited in the Walker Museum at the University of Chicago, of which Dr. Weller was curator. After receiving the degree of Ph.D. in June 1915, Dr. Mather accepted appointment as assistant professor of geology in Queens University, Kingston, Ontario. Here he remained for the three years prior to his appointment as Dr. Carney's successor in Denison.

During the summers of 1917 and 1918 Dr. Mather had been assigned as geologist of the U. S. Geological Survey to work in connection with the petroleum resources of Kentucky and Oklahoma, work urgently needed because of the importance of fuel oil and gasoline for the Navy and the Expeditionary Forces during the War. Since then he has devoted far more attention to petroleum geology than to physiography and paleontology, the fields in which he had been primarily interested hitherto. Shortly after moving to Granville in 1918, he was elected permanent secretary of the Denison Scientific Association and for six years served as editor of the scientific bulletin. But an unexpected interruption occurred during the first of those years. Just as college was opening in September, Dr. Mather was offered a commission as Captain in the Engineer Corps of the U. S. Army, with the understanding that he would be attached to the General Staff for duty as a geologist in France. It was arranged that he should have leave of absence from Denison for that important service and Dr. Maurice G. Mehl was appointed acting professor of geology for one year. As it happened, however, Dr. Mather contracted influenza while in Washington qualifying for his com-

mission and did not recover until early November, when the termination of the war cancelled the plans for overseas duty. Thus it befell that for the balance of the year 1918–19, Denison had two professors of geology.

The first number of volume 19 of the Bulletin was issued in April, 1919. True to the established custom, it contained a paleontological paper by Dr. Foerste, this time a study of the echinoderms of the Brassfield formation of Ohio. There was also a report on America's advance in potash production by W. Clarence Ebaugh, who had joined the Denison faculty as professor of chemistry in 1917, and who was destined to become editor of the Journal of the Scientific Laboratories six years later. In addition this number contained two papers by Dr. Mehl, one on the use of outline charts in teaching vertebrate paleontology and one dealing with the geographic distribution of petroleum. These accurately reveal Dr. Mehl's major interests within the broad field of geology. At Chicago, where he received his doctorate in 1914, he had been one of Dr. S. W. Williston's most brilliant students in vertebrate paleontology, and while teaching his specialty at the University of Oklahoma in 1915, 1916 and 1917 he had been unable to escape the lure of the nearby oil fields.

To the September, 1919, issue, Dr. Foerste contributed some notes on four genera of early Paleozoic trilobites, and Dr. Robert J. Kellogg a study of experiments for the graphic recording of speech vibrations. Dr. Kellogg at that time was professor of modern languages in Denison, a post which he occupied from 1918 to 1920. There was also a paper by Dr. Mather on the manipulation of the telescopic alidade in geologic mapping. This included a description of special techniques developed by the geologists of the U. S. Geological Survey in the mid-continent oil fields during 1917 and 1918. There was subsequently such a demand for copies of this issue that the reserve supply has long since been exhausted. To complete this issue there was a brief comment on the importance of drainage area in estimating the possibilities of petroleum production from an anticlinal structure, written jointly by K. F. Mather and M. G. Mehl.

Beginning with the third part of volume 19, published in May,

1920, the name of the Bulletin was changed to "*Journal of the Scientific Laboratories*" in accordance with a ruling of the postal authorities to permit its distribution under second class mailing privileges as a part of the Denison University Bulletin, a title which could then be applied without confusion to all the official publications of the University. This issue was edited by Dr. Mather while he was in Granville for a few weeks, between two extended exploratory journeys in South America. In the fall of 1919, he had accepted employment as geologist for Richmond Levering and Company, and once more had been granted leave of absence from his university duties in order to examine the petroleum possibilities of the eastern part of Bolivia. Dr. James H. Hance, who had received his doctorate in geology at Chicago in 1918, was appointed to take charge of the department at Denison during his absence. Dr. Mather sailed from New York in October, landed at Mollendo, Peru, crossed the Eastern Andes from La Paz, Bolivia to Santa Cruz and after several weeks in and near the eastern foothills of the Andes, returned to Granville in April, 1920, by way of Buenos Aires and London. Leaving again in June, he crossed the Andes from Arica, Chile, to northeastern Bolivia and thence, after many weeks in the jungle, down the Madeira and the Amazon to Para, Brazil, arriving at last in Granville the day before Christmas. Although the major scientific results of these journeys were published in the Bulletin of the Geological Society of America, the Geographical Review, and Le Vie d'Italia e del l'America Latina, one article was contributed to the Journal as noted below.

In this issue of the Journal (May, 1920) there was a paper on "Psychological Factors in Vocational Guidance," presented by Thomas A. Lewis, as the address of the retiring president at the meeting of the Denison Scientific Association, October 7, 1919. Dr. Lewis had been appointed professor of psychology in 1914 and has continued in that position to the present time. There were also two papers by Dr. Mehl and a study of the fauna of the Kimmswick and Plattin limestones of northeastern Missouri by Dr. Foerste.

The fourth and final part of volume 19 was published in Sep-

tember, 1921. The first article consisted of an address entitled "Education for Scholarship" delivered by William E. Castle at the Commencement Exercises, June 15, 1921. Dr. Castle graduated from Denison in 1889 and received the degree of Ph.D. from Harvard in 1895. Two years later he was appointed to the Harvard faculty and since 1908 he has been professor of zoology, retiring in 1936 as one of Harvard's most distinguished professors emeriti. There was also a paper on the cytology of the sea-side earwig by Sidney I. Kornhauser, professor of zoology in Denison from 1919 to 1922. The research upon which this paper was based had been begun at the Biological Laboratories at Cold Spring Harbor, Long Island, N. Y., during the summer of 1915, had suffered many delays due to the World War, but had been continued in the Zoological Laboratories at Denison since the spring of 1920. The third article in this issue was contributed by Dr. Foerste and the fourth was a somewhat philosophical essay by the editor.

Volume 20 consisted of three parts, published in November, 1922, June, 1923 and December, 1924. Dr. Kornhauser contributed a review of the biology of sex-determination, and Dr. Mather a description of the meander patterns of two of the streams in eastern Bolivia which he had mapped while on his second South American journey. To round out the November, 1922, issue there was also an account of the primitive musical instruments in the Denison collection by Karl H. Eschman, Denison, 1912, who since 1913 has been director of the Denison Conservatory of Music.

Part 2 of Volume 20 (June, 1923) contained five articles. There was another beautifully illustrated paleontological study by Dr. Foerste and the first of a series of zoological papers by Arthur W. Lindsey, who since 1922 has been professor of zoology in Denison. Dr. Paul Biefeld, director of the Swasey Observatory and professor of astronomy from 1911 until his retirement in 1934, described the occultation of Venus by the moon as observed in Granville on January 13, 1923, and Dwight W. Moore reported the results of a botanical survey of the Denison campus. Dwight Moore had graduated from Denison in 1914 and from 1920 to 1923

he was instructor in biology while continuing his studies under Professor Stickney and at Ohio State University. Denison conferred upon him the degree of Master of Science in 1921, and in 1924 he received his doctorate at Ohio State. Since 1926 he has been head of the department of botany in the University of Arkansas. The last article in this issue of the Journal was a study of the underground migration of oil and gas, contributed by the editor.

The third and final part of Volume 20 (December, 1924) likewise contained five articles, one by Dr. Foerste, two by Dr. Lindsey and one, a report on the Einstein Theory, by Dr. Biefeld. There was also a report on the geology of Giles County in southwestern Virginia by George D. Hubbard and Carey G. Croneis. Professor Hubbard of Oberlin College had conducted field classes in that region during several summers and Carey Croneis, who graduated from Denison in 1922, had been associated with him there as student and assistant. This joint paper was the first publication of the large body of data gathered since 1908. During 1922–23, Carey Croneis had been a graduate student at the University of Kansas, associated with Dr. Raymond C. Moore, Denison, 1913, who was then head of the department of geology in that institution, and in 1923 he received the degree of Master of Science there. At the time of publication of this paper on Giles County, he was instructor in geology at the University of Arkansas. Later he continued his studies at Harvard, receiving the degree of Ph.D. in 1928, and he is now Dr. Weller's successor at the University of Chicago.

The completion of volume 20 marked also the end of Dr. Mather's term as editor of the Journal. Even before the publication of the final number of that volume, he had resigned from the Denison faculty to accept appointment as associated professor of physiography at Harvard, where from 1926 to 1932 he was chairman of the department of geology, and where since 1927 he has been professor of geology. Dr. W. C. Ebaugh became editor of the Journal in 1924 and all subsequent issues have been under his supervision.

William Clarence Ebaugh was born in Philadelphia, Pa., Janu-

ary 3, 1877. After graduating from the University of Pennsylvania in 1898 he was employed for a time as chemist in iron and steel laboratories near Reading, Pennsylvania, and then continued his studies in the graduate school of his Alma Mater, which conferred upon him the degree of Doctor of Philosophy in 1901. After a year as a member of the faculty of Kenyon College, he went to Salt Lake City, where he served as chemist for the American Smelting and Refining Company and as public analyst, until in 1903 he became director of the department of chemistry in the University of Utah, where he remained until 1915. From 1915 to 1918 he practiced as consulting and analytical chemist in Salt Lake City, Utah, and during the World War served as chairman of the Naval Consulting Board's Utah organization, and as secretary of the State of Utah Council of Defense, the organization which handled the war work of that state. In 1917 he accepted appointment as professor of chemistry at Denison, and reported for duty in September, 1918.

The first part of volume 21 appeared in March, 1925. Dr. Foerste saw to it that the new editor got off to a good start by contributing seventy pages of notes on cephalopod genera, chiefly coiled forms from the Silurian rocks. Dr. Lindsey contributed a systematic study of the Hesperioidea collected by the Cornell University entomological expedition to South America in 1919 and 1920. Dr. Biefeld added an account of a photographic record of the solar eclipse of January 24, 1925, as seen from Swasey Observatory, where the maximum obscuration was about ninety-five per cent.

The second part of volume 21, issued in September, 1925, consisted of but one article, a thorough study of the agricultural geography of the Salt Lake oasis. This was the doctoral dissertation of Charles Langdon White, accepted by Clark University in partial fulfillment of the requirements for the degree of Ph.D. conferred upon its author in June of that year. Langdon White had graduated from Denison in 1920 and had continued his training in geology and geography at the University of Chicago and later at Clark University. Between 1926 and 1928 he was associate professor of geography in Miami University, Oxford,

Ohio, and then after three years as professor of geography at Randolph-Macon Woman's College, he was appointed to a similar position in Western Reserve University, where he is now head of the department of geology and geography.

This twenty-first volume of the Journal was completed with the publication in September, 1926, of a number containing three articles. In it was a systematic treatise concerning certain Paleozoic cephalopods by Dr. Foerste, a description of brachiopods from the St. Clair limestone in Arkansas by Norman L. Thomas, and some notes on the preparation of hydrogen sulfide and hydrogen iodide by Dr. Ebaugh. Norman Thomas is another of the group of geologists who received their first training in that science at Denison. Graduating in 1920, he also went to the University of Chicago for graduate study, and has since established for himself an enviable reputation as a petroleum geologist in the mid-continent oil fields.

Beginning with volume 22, the Journal has been published in annual volumes. Previously, a volume consisted of three or four hundred pages, the publication of which extended over variable periods of two or three years, but henceforth the articles issued during each calendar year constituted a "volume" regardless of bulk. In consequence this volume consists of two parts, dated March and October, 1927. In the first of these, there was a long article on the Ordovician and Silurian cephalopods of the Hudson Bay area by A. F. Foerste and T. E. Savage, some notes on the philogeny of a genus of Hesperioids by Dr. Lindsey, and two papers on the Blue Ridge and its gravels by Frank J. Wright. Most of the cephalopods described in this issue had been collected by Dr. Savage, professor of geology in the University of Illinois, and his colleague, F. M. Van Tuyl, in the region bordering the west shore of Hudson Bay, in 1916. With customary thoroughness, however, Dr. Foerste had studied also many additional specimens collected by other geologists in the northern part of the continent. All these were critically considered in this scholarly memoir, in which much attention was also paid to the correlation of strata across a vast area.

Frank J. Wright was Dr. Mather's successor as professor of

geology in Denison University, and the physiography of the Southern Appalachians was one of his specialties. He had graduated from Bridgewater College in Virginia in 1908, had received a Master's degree from the University of Virginia in 1911, and had studied at Columbia under Douglas Johnson, whose intimate relationship to Denison was noted by Dr. Foerste in the account of the earlier history of the Bulletin of the Scientific Laboratories, to which reference has already been made. After receiving the degree of Ph.D. from Columbia in 1918, Dr. Wright had been professor of geology at Bridgewater College until called to Denison in 1924.

The year 1927 marked the fortieth anniversary of the founding of the Denison Scientific Association. In celebration of this anniversary three "general addresses" were delivered in Swasey Chapel on three successive Wednesdays in April, and on April 19 an anniversary dinner was followed by "commemoration addresses" by C. Judson Herrick and Alfred D. Cole, whose connection with the Association and the Journal has been noted in the foregoing portion of this article and in Dr. Foerste's account of the earlier days of the publication and its sponsoring society. These addresses were transcribed by stenographers, and the copy thus prepared was printed as the second part of volume 27 of the Journal.

The first of the general addresses was delivered by Dr. Robert A. Millikan, Director of the Norman Bridge Laboratory of the California Institute of Technology, whose subject was "Science and Religion." Dr. Mather was the second speaker in this series and chose as his topic, "Forty Years of Scientific Thought Concerning the Origin of Life." The third address was entitled "Charles Darwin, a Pioneer in Experimental Evolution" and the speaker was Dr. George A. Dorsey, Denison, 1888, best known to the general public as the author of *Why We Behave Like Human Beings*. Dr. Herrick's subject was "Science and Living"; Professor Cole recounted "The Founding of the Denison Scientific Association."

Volume 23 of the Journal was published in three parts in January, July and December, 1928. To each part Dr. Foerste

contributed a long paper dealing with Paleozoic cephalopods. Dr. Mehl, then associate professor of geology in the University of Missouri, sent a description of a new genus of ichthyosaurs for the January issue and a paper on the phytosaurs of the Wyoming Triassic for the July number. In that issue there was also another article on the St. Clair brachiopods by Norman L. Thomas. In the December number, Dr. Lindsey described a collection of Hesperioidea which had been secured by George D. Morgan in the vicinity of Kartabo, British Guiana in 1925. George Morgan graduated from Denison in 1924, received the degree of Master of Science from the University of Pittsburgh in 1926, that of Ph.D. from Ohio State University in 1936, and since 1927 has been a member of the department of zoology at Denison. To complete this volume of the Journal, Dr. Wright contributed a paper concerned with the erosional history of the Blue Ridge.

The year 1929 was an unusually productive one for the group of Denison scientists. Volume 24 of the Journal, published that year in three parts, totals 427 pages. To the April and August numbers, Norman L. Thomas contributed descriptions of certain trilobites from the St. Clair limestone and Dr. Foerste two additional papers on the cephalopods of the Canadian and Arctic Paleozoic rocks. In each of these numbers there was also a geographic essay by Langdon White, dealing with the location factors of the iron and steel industry in Cleveland and in the Buffalo district. Similarly, to the April and August numbers Raymond C. Moore contributed two paleontological papers, one describing a new genus and several new species of ostracods from late Paleozoic rocks of Texas and Oklahoma, the other a large fish spine of similar age from north central Texas. Dr. Moore graduated from Denison in 1913 and—like so many other students of Dr. Carney—continued his geological training at Chicago where the degree of Ph.D. was conferred upon him in 1916. Then he joined the faculty of the University of Kansas; there he has been for many years professor of geology and paleontology, as well as state geologist.

One other paper in the April, 1929, number was by Dr. Biefeld —a notation of a photographic record of the total eclipse of the

moon as observed from the Swasey Observatory on November 27, 1928. The December, 1929, issue of the Journal contained a further report on his studies of cephalopods by Dr. Foerste, a description of a new genus of mosasaurs by Dr. Mehl, and an account of a case of stream piracy near Asheville, North Carolina by Dr. Wright. There was also an interesting study of the relation of the cost of motor vehicle transportation to highway finance by Bruce D. Greenshields, who since 1926 has been professor of engineering science at Denison.

Volume 25 was published in three parts in April, August and December, 1930. To the April issue, Dr. Foerste contributed another article on Paleozoic cephalopods, the class of invertebrates to which he devoted nearly all of his research during the last ten years of his life. Dr. White extended his studies of the iron and steel industry to Youngstown, Ohio, and Dr. Moore described some new species of bryozoans from the Pennsylvanian rocks of Texas. In the August number Winford L. Sharp reported the results of research concerning the ability of persons to locate observed objects in the horizontal plane, in which he used his students and colleagues at Denison as his "guinea pigs." Dr. Sharp, a graduate of Franklin College, was associate professor of psychology in Denison from 1928 to 1930 and has since been continuing his work at Wooster. The August number also contained the Woodland Prize essay in chemistry. This prize is awarded annually to a junior in Denison University and that year was won by Milton Finley, whose essay was entitled, "Petroleum Products for Internal Combustion Engines."

The December number of volume 25 contained a systematic study of the actinoceroid cephalopods of east-central North America by A. F. Foerste and Curt Teichert. The latter was in this country as a fellow of the Rockefeller Foundation, having graduated from the University of Königsberg in 1927; his wife prepared many of the photographs which illustrated this joint memoir. Interestingly enough, Professor Rinji Endo of Manchurian Teachers College, Mukden, Manchuria, had found in September, 1927, in South Manchuria an actinoceroid cephalopod which proved to belong to the rare genus Nybyoceras. Through Dr.

Teichert, who at about that time was studying the East Baltic cephalopods, he was placed in close contact with the work which Foerste and Teichert were doing. As a consequence, this issue of the Journal contained a sort of appendix to their memoir in which Professor Endo described his fossil and named it Nybyoceras foerstei in honor of Dr. Foerste.

The twenty-sixth volume of the Journal consisted of two memoirs published in April and December, 1931. The first of these was a comprehensive work on "The Hesperioidea of North America" by A. W. Lindsey, E. L. Bell and R. C. Williams, Jr. As inferred from the titles of Dr. Lindsey's earlier contributions to the Journal, he had long been especially interested in this particular group of insects, the "skippers," intermediate in many ways between the butterflies and moths. In rounding out his systematic studies of them in this memoir he enlisted as his collaborators Captain Williams and Mr. Bell, who had done extensive work in this same field. The second number (December, 1931) was a monograph by Dr. Wright in which were set forth the results of his geomorphic studies of the older Appalachians of the southern states.

Volume 27 (1932) likewise consisted of but two papers. The first, published in June, was an orderly summary of the geomorphology of Central Ohio, the first comprehensive treatment of the physiographic development of that broad region, by Henry S. Sharp. Dr. Sharp, a graduate of Cornell in 1924, had received the degree of Ph.D. from Columbia in 1929, and from 1930 to 1932 was assistant professor in the department of geology in Denison. Thence he returned to Columbia in the fall of 1932 as instructor in geology. The second article, published in December, was the first part of a bulky treatise on the cephalopods of Black River age from Minnesota, Wisconsin, Michigan and Ontario by Dr. Foerste.

The second part of this treatise was published in the April, 1933, number of the Journal. To complete that issue (volume 28, articles 1–3) Charles E. Welling contributed a study of the change in mass of the anode of the aluminum-lead cell, and Dr. Ebaugh added a valuable note on the balancing of chemical equations,

in which he paid appropriate tribute to the contribution of Otis Coe Johnson in 1880 toward the removal of this ever-recurring stumbling block in the path of students of chemistry.

This twenty-eighth volume of the Journal was completed with the publication in October, 1933 of a treatise on the Ordos Desert of Inner Mongolia by George B. Cressey, in which the author reported the results of geographic studies in that pioneer belt on the frontier of Asiatic civilization. Dr. Cressey had graduated from Denison in 1919, and after receiving the degree of Ph.D. from the University of Chicago in 1923 he had served as professor of geology in Shanghai College, China, from 1923 to 1929. The following year he spent as research associate in the department of geology and geography in Harvard University, and since 1931 he has been chairman of the equivalent department in Syracuse University.

Volume 29 was published in three parts, in April, August, and December, 1934. The April issue was a treatise on the geomorphology of the "Newer Appalachians" between the Potomac and the New rivers in Virginia and West Virginia, by Dr. Wright, who had spent the summers of 1932 and 1933 in field work in that region. The scientific value of this research is indicated by the fact that Dr. Wright had received a grant from the Penrose Fund of the Geological Society of America to enable him to pursue it. The August number likewise consisted of one long article, this time another of Dr. Foerste's studies of fossil cephalopods. To the December issue he also contributed the account of the earlier history of the Bulletin of the Scientific Laboratories, with its many interesting personal touches, to which reference was made in the opening paragraph of the present paper. With it there was a report concerning the evidence of ice action in the Teays Valley, West Virginia, by Julian J. Petty who had graduated from Denison in 1924 and then had pursued his graduate studies in geology at Iowa and Harvard.

During 1935, the three numbers which constitute volume 30 of the Journal were similarly issued in April, August and December, a publication schedule which the editor apparently was then attempting to standardize. In each number there was an article

by Dr. Foerste, two of which were important papers in the long series of cephalopod studies and the third was a study of the correlation of Silurian formations in a large area surrounding Cincinnati. There was also, in the December number, a joint paper by E. O. Ulrich and A. F. Foerste in which were described many new genera of early Paleozoic cephalopods. Dr. Ulrich of the U. S. Geological Survey, now retired, had long been one of Dr. Foerste's closest friends and most valuable scientific associates; it was particularly appropriate that they should collaborate in this important memoir, late in their productive period.

For this was Dr. Foerste's penultimate contribution to science. He died at his home in Dayton, Ohio on April 23, 1936, almost the same day that his last cephalopod paper was published in the next volume of the Journal. Thus his career as a scientist practically synchronized with the first half-century of publication of Denison's scientific journal. He contributed to its first number in 1885, and nearly half the total number of pages in the thirty volumes published between that date and the close of 1935 were written by him.

In his "Earlier History of the Bulletin of the Scientific Laboratories," Dr. Foerste records the events of his youth which led him into his scientific career and made him C. L. Herrick's closest associate in the founding of this publication, but with characteristic modesty he tells nothing of his own distinguished career in subsequent years. After graduating from Denison in 1887, he studied at Harvard where he received the master's degree in 1888 and the doctor's degree in 1890. During the next two years he continued his scientific training at Heidelberg and Paris. In the fall of 1893 he was appointed teacher of physics in the Steele High School in Dayton, and there he remained until his retirement at the age of seventy in 1932. Subsequently he spent most of his time in the U. S. National Museum in Washington, where he was promptly appointed associate in paleontology.

Lacking the prestige of a connection with a great university or research organization during most of his life, and under no compulsion to do research in order to gain advancement in position, he nevertheless established himself as one of America's most

renowned and productive paleontologists. At various times he was engaged by the U. S. Geological Survey and the geological surveys of Ohio, Indiana, Kentucky and Canada for special assignments in his particular line of work. In 1928 he was president of the Paleontological Society of America; in 1931, of the Ohio Academy of Science. To him was awarded the Marsh Fund grant of the National Academy of Sciences and for several years he was the representative of the Paleontological Society on the National Research Council. No one could have devoted himself more indefatigably and unreservedly to any object or objective than did Dr. Foerste to his early Paleozoic fossils and their meaning. Seemingly, every moment of his waking hours not reserved for teaching physics to his high-school boys and girls was occupied by his paleontological research. He never married, and the energies and resources which would otherwise have been expended upon a family were concentrated upon his highly specialized scientific studies.

But teaching physics was not just an irksome necessity, to provide sustenance and the funds needed for research and publication; instead it was a task in which Dr. Foerste found great delight. For he was teaching, not only physics, but boys and girls. And those boys and girls occupied a place in his scheme of things which was scarcely second to that in which his fossils were enthroned. Many a student in the Steele High School will forever be indebted to the quiet, austere scholar who gave him a new perspective upon life and helped him acquire those scientific habits of mind so necessary for harmonious living in this age of gadgets and committees.

If the only claim for approval advanced by the Journal of the Scientific Laboratories of Denison University were that it had served as a medium for publication of the majority of August F. Foerste's contributions to knowledge, that of itself would be ample justification for its existence. We who are jealous for the high esteem of Denison will always be proud of the fact that the honorary degree of Doctor of Science was conferred upon this worthy son of Denison by his Alma Mater in 1927.

Returning now to the thirtieth volume of the Journal, two addi-

tional articles should be noted. To the April number, W. E. Forsythe contributed an interesting account of the development of new light sources for photographic purposes, in which especial attention was directed to the laboratory work which resulted in the perfecting of the photo-flash bulb. Dr. Forsythe graduated from Denison in 1907, and received the degree of Ph.D. from the University of Wisconsin in 1911. Since 1913 he has been a research physicist in the employ of the General Electric Company, for a part of the time in the Nela Research Laboratory and more lately in the lamp development laboratory. In the August issue of that volume, there was also a study of the phenomenon of wetting films by C. W. Chamberlain and K. L. Warren. Since resigning from the presidency of Denison in 1927, Dr. Chamberlain has been professor of physics at Michigan State College and the research reported in this article was prosecuted in his laboratory there, partly through the use of the compound interferometer which he had designed at Denison years before.

Summarizing this record of publication throughout twenty-seven years in quantitative terms, it may be noted that articles devoted to paleontology and stratigraphy are by far the most numerous and voluminous of all the contributions which have been printed in the Journal. A total of 3095 pages was occupied by such articles in the seventeen volumes here under survey. This is 59.2% of the total number of pages in those volumes. This preponderance is due partly to the fact that Dr. Foerste was so prolific in his research and so eager to use the Journal as his medium of publication, and partly to the fact that the description of a fossil fauna is necessarily a very wordy task which necessitates the recording of many minute details and forbids summarized presentations. Of the grand total of 642 full-page plates which illustrate these seventeen volumes, 478 portray the fossils described in these paleontological papers. The result is that a file of the Journal is absolutely indispensable to anyone engaged in research involving a study of Paleozoic life. Incidentally, the cost of photographs and plates was borne in almost every instance by the authors themselves. Dr. Foerste alone must have spent several thousands of dollars in this way.

Next in quantitative importance are the papers devoted to glacial geology and physiography, which total 650 pages or 12.4% of the seventeen volumes. Geography occupies 526 pages, 10% of the whole. Adding the articles on field methods in geology (46 pages) and on minerals and ore deposits (50 pages), the total for the earth sciences is 4367 pages, 83.5 % of the entire publication. Zoology ranks next with 272 pages or 5.2%, physics follows with 89 pages or 1.7%, and chemistry with 61 pages or 1.2% is fourth among the major sciences. Botany, mathematics, engineering science, astronomy and psychology occupy less than one percent each of the total pages in these volumes. If to philosophy we assign the hundred pages of the "Herrick Memorial Volume," the articles under that heading occupy 2.4% of the pages. A slightly larger fraction (2.8%) is devoted to commemorative articles and ceremonial addresses.

Among the contributions to these seventeen volumes, three may be identified as doctoral dissertations and two as masters' theses. Two are essays for which prize awards were made in undergraduate competitions at Denison, and several are papers submitted in connection with seminars or research courses by Denison students. The doctoral dissertations were accepted by candidates for the Ph.D. degree at Cornell, Chicago and Clark. They were written by Frank Carney, Denison professor, Kirtley Mather, Denison alumnus and later a member of the Denison faculty, and Langdon White, Denison alumnus. Thus the Journal has faithfully accomplished the purpose of serving as a medium for the publication of the results of productive scholarship in the sciences and at the same time has been distinctively a record of scientific work at Denison and by Denisonians.

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(1) The Earlier History of the Bulletin of the Scientific Laboratories of Denison University; *Journal of the Scientific Laboratories of Denison University*, *29*, 205–227 (1934).

(2) *loc. cit.*, 219.

(3) *loc. cit.*, 222–3.

DENISON SCIENTIFIC ASSOCIATION

Organized April 16, 1887

REPORT OF THE PERMANENT SECRETARY FOR THE YEAR 1935–1936

Officers of the Association during the college year 1935–1936 were as follows:

M. E. STICKNEY, *President*
A. C. LADNER, *Vice-President*
W. C. EBAUGH, *Permanent Secretary and Editor*
CHARLOTTE RICE, *Recording Secretary and Treasurer*
L. E. SMITH, *Librarian*

Meetings were held in the Physics Lecture Room, Barney Science Building, Tuesday evenings as indicated herewith.

October 15

NATURAL BRIDGE, AND OTHER GEOMORPHIC PROBLEMS IN THE SOUTHERN APPALACHIAN VALLEY.

F. J. WRIGHT, Retiring President.

The origin of the Natural Bridge, Va. (a famous attraction for tourists), the history of the Upper Roanoke River, and the origin of the limestone lowlands of Southern Tennessee and Alabama were discussed, and their relationships to the geomorphology of the Southern Appalachian Mountains shown.

October 29

THE NEW GERMANY. H. J. SKIPP.

What is really this so-called New Germany? How does it differ from the pre-war Germany and the Germany of the 1920's? Has there really been a revolution—or two revolutions—since Bismarck passed? Who is Adolf Hitler? To what are we to attribute his great popularity in Germany? Do his doctrines

give us anything new? What in fact is the National Socialist Movement? How does "Nazi-ism" differ from "Fasci-ism" and from Marxian Socialism? Why are Jews unwelcome in Germany? What is the German Youth Movement? What is the attitude of the National Socialist party to religion? Is war an inevitable consequence in the New Germany? These and other points in the National Socialist program were discussed.

November 12

COMETS AND METEORS. F. D. MILLER.

"When beggars die there are no comets seen; . . ."

Comets, once portents of the fate of heroes and nations, are now known to be gigantic though tenuous wanderers through the solar system. In 1910 the tail of Halley's comet switched across the face of the earth. Although the deadly gas cyanogen is one constituent of cometary tails, no ill effects resulted from the encounter. Such comets return to the neighborhood of the sun century after century, ultimately disintegrating into scattered clouds of cosmic debris called meteors. These remnants often collide with the earth. Usually small in size, the result is a brilliant dart of light across the night sky—a shooting star. More rarely the colliding meteor is large, and with a blaze of light and a roar, plunges to the ground. One such celestial cannonball struck the earth twenty-seven years ago in a remote part of Siberia. Had it struck in the center of Columbus, Newark, Delaware and Chillicothe would have been laid in ruins, and the sound of the crash would have been heard in Philadelphia. A crater nearly a mile across marks the grave of one such monster in Arizona.

November 26

HIGH SCHOOL GEOMETRY FROM THE STANDPOINT OF RELATIVITY. F. B. WILEY.

Starting with some of the elementary figures of Euclidean geometry, such as the circle and the parallelogram, and with some of the well-known theorems regarding them, the figures were reconstructed and the theorems reworded so as to make them

true relatively. Thus it was shown how one could "relativize" so to speak ordinary Euclidean geometry into non-Euclidean geometry.

December 10

CARLSBAD, NEW MEXICO: ITS CAVERNS AND POTASH MINES. W. C. EBAUGH.

One of the recently created National Parks is that at Carlsbad, New Mexico, covering an area under which are some of the most wonderful caverns, both as to size and beauty, known to man. And near the Caverns are two actively producing potash properties the output of which can make America independent of foreign sources of this indispensable material. These were described and illustrated, and their importance to agriculture and industry emphasized.

January 7

MODERN ALCHEMY. L. E. SMITH.

Youth and Riches have induced man to search for the elixir vitae and the philosopher's stone during the last 2000 years. This search has produced some evil, but no doubt—directly or indirectly—it has been an agent for much good. At present the ideal elixir has eluded the efforts of all searchers, yet the fact remains that the average life-expectancy of man has been increased materially through science. In the search for the philosopher's stone the point of emphasis has changed, yet there are actually being made transmutations of the elements. The modern processes are not those visioned by the alchemists, but their results are none the less marvelous. The products of such transmutations are not available in commercial quantities; it would be unwise to make sweeping predictions as to the outcome of such work in the future. As of old, visions still exist in the minds of men. Recent progress in the field of nuclear structure and sub-atomic phenomena was outlined as an illustration in point.

January 21

FUNDAMENTAL PROBLEMS IN TRAFFIC BEHAVIOR.

B. D. GREENSHIELDS.

Highway safety is the most difficult problem confronting the highway engineer, yet he must build roads offering as few opportunities as possible for traffic accidents. If the ultimate goal in safety is to be reached, the automobile driver must then exercise sufficient skill and judgment to avoid accidents. Can the causes of accidents be reduced to a few general classifications? Do automobile drivers perform in certain ways because their natures permit them to do nothing else? Is it possible to develop a workable automobile driver's test? Is there any definite relationship between the speed of a driver's mental and physical reactions and his ability as a safe driver? Can highways be made safer by employing different methods of design in construction? At the present rate of automobile accidents, out of each 100 children born, three may expect to die by automobile accidents and 80 may expect to be injured. In 1934 approximately 35,000,000 dollars were spent on the construction and maintenance of highways in Ohio, while the total cost of highway accidents was more than 34,000,000 dollars. What would be the public's reaction to such a record by the railroads? Such questions were discussed in full.

February 11

UNDERSTANDING NORMAL PERSONS THROUGH THE STUDY OF ABNORMAL ONES. T. A. LEWIS.

In studying patients at a clinic one often recognizes in an exaggerated form traits possessed by the observer himself: it is as though an amplifier or resonator were used to intensify the overtones, but once having learned what they are, recognition can be made later without the aid of the amplifier. The essential difference between the normal and the abnormal individual is that the former has certain traits in balance, while the latter suffers from too much or too little of these same characteristics. A

feature may be conspicuous by its absence, as when a dementia praecox patient becomes so taciturn he is mute; or a feature may become conspicuous through being excessive, as in the case of a maniac who laughs when there is every reason to moan. Lying between the normal and ultra-abnormal is the borderland of psychoneurotic—the person with a phobia, or an obsession, or a feeling of insecurity; and the hysteric, who appears in a score of different manifestations. They also help the vain normal to know himself.

February 25

RUBBER—FROM TREE TO TIRE. R. M. REEL (Pharis Rubber Co.).

The production of rubber, its process of manufacture, its testing and use, were shown both by moving pictures and by raw, intermediate and finished products.

March 10

TURKEY, OLD AND NEW. S. N. FISHER.

New Turkey is only thirteen years old, so the pictures shown were more concerned with the life and conditions of the old régime rather than the new. Problems faced by the new government in rehabilitating the nation were explained. Scenes ranged from the fruitful and fertile coastal areas of western Turkey to the dry barren regions of central Asia Minor, from the aqueducts of Justinian to the modern buildings of Ankara, the present capital of the Turkish Republic, and from poverty-stricken peasants to ambitious youths of westernized Turkey.

March 24

ANIMAL COMMUNICATION. A. W. LINDSEY.

Man talks: he has a long ancestry of communication to which he must be true, and in articulate speech he has a medium of expression of remarkable facility. With animals in general incidental communication is no less interesting than special types, and many strange methods are in use. Yet the end is always the same—to know what is happening in the surrounding world in

order that the individual may live in harmony with its environment. Many specific examples of animal communication were discussed.

April 14

WHAT DENISON STUDENTS THINK ABOUT MARRIAGE. FOREST WITCRAFT.

Probably the two most important decisions which young people are called upon to make concern the choice of a life-work, and the choice of a life-partner. And yet we have assumed, almost down to the present day, that by some miracle of providence, we would drift automatically into the vocations for which we were best fitted, and that by similar mysterious guidance we would unerringly pick the right partner and find ourselves instinctively equipped to solve the complex and difficult problems of family life. Today hundreds of American colleges and universities are undertaking, through specific courses, to help their students to think more intelligently about many aspects of the problem. The summary and analysis of data collected from students at Denison University, enrolled in the current course in the Family and Marriage, formed the basis of the subject as presented.

April 28

ABC's OF GAME MANAGEMENT. J. W. STUBER (Ohio Conservation Department).

Methods and results of game conservation and management, employed by the State of Ohio Department of Conservation, were explained and illustrated in detail. This included the protection of game, its propagation and distribution, the maintenance of nurseries and hatcheries, war against predatory animals, and the financial costs and returns to the people of the State of Ohio.

May 12

COMMON ECONOMIC FALLACIES. L. J. GORDON.

The subject matter of economics is so closely related to individual welfare and so much a part of one's daily living that it is not surprising when individuals develop strong beliefs in the

desirability or undesirability of certain economic policies. Like medicine, economics has its quacks whose panaceas and remedies contain just enough truth to render them exceedingly difficult to expose. Moreover, the subject matter of economics is such that truth and falsity cannot be isolated in a laboratory, nor does the professional economist have authority to demonstrate the validity of his theories in practice. Questions considered were: Are there any economic laws? Is a dollar always worth a dollar? Should money be spent at home? Does saving take money out of circulation? Is a protective tariff always or ever beneficial? Can the United States be economically self-sufficient? Can Germany and the Allies pay reparations and debts if they can afford to rearm? Can the burden of a war or depression be shifted to future generations by means of borrowing to meet emergency expenditures? Is a man paid what he is worth? Can any man who wants a job get one? Were the recent floods an economic blessing? Is a sales tax equitable? Is tithing just? Is the New Deal socialistic?

Three numbers of our JOURNAL OF THE SCIENTIFIC LABORATORIES OF DENISON UNIVERSITY were issued, viz.:

Vol. XXX, Articles 3–4, pp. 119–230, August, 1935.

Correlation of Silurian Formations in Southwestern Ohio, Southeastern Indiana, Kentucky, and Western Tennessee; Aug. F. Foerste. 87 pp.

A Study of the Phenomenon of Wetting Films; C. W. Chamberlain and Kenneth Lyle Warren. 25 pp., 4 plates, 1 fig.

Vol. XXX, Articles 5–6, pp. 231–303, December, 1935.

The Cephalopods of the Maquoketa Shale of Iowa; Aug. F. Foerste. 27 pp., 11 plates.

New Genera of Ozarkian and Canadian Cephalopods; E. O. Ulrich and Aug. F. Foerste. 32 pp., 1 plate.

Vol. XXXI, Articles 1–2, pp. 1–92, April, 1936.

Hierosaurus colei; a new aquatic Dinosaur from the Niobrara Cretaceous of Kansas; M. G. Mehl. 20 pp., 3 plates.

Silurian Cephalopods of the Port Daniel Area on Gaspé Peninsula, in Eastern Canada; Aug. F. Foerste. 72 pp., 23 plates.

With the death of Dr. August F. Foerste, at Dayton, Ohio, on April 23, 1936, was ended a career as geologist, paleontologist and teacher of physics that extended over more than fifty years.

This JOURNAL was used by Dr. Foerste as an outlet for many of his studies, and the fact that his name appears as author in the first volume (1885), in the last volume (1936), and in most of those intervening, speaks well for his industry as an investigator and writer. A biography and appreciation of our long-time contributor will appear in an early number of this JOURNAL.

Since 1935 marked the end of fifty years life of this JOURNAL, and 1937 will bring the fiftieth anniversary of the founding of the DENISON SCIENTIFIC ASSOCIATION, it is fitting that a list of exchanges, libraries, universities, museums, research and other scientific institutions, with which we have connections, be made a matter of record at this time. Our Accession List and Mailing List follow. It might be added that the International Exchange Service of the Smithsonian Institution, Washington, D.C., has given splendid coöperation, throughout a long period of our history, in facilitating the forwarding of scientific periodical literature to and from us; we take pleasure in acknowledging our obligation to this branch of the Institution's work "for the diffusion of knowledge."

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The Fan Memorial Institute of Biology
Peiping, China
Annual Report of the National Library
Peiping, China
Yenching University
Peiping, China
Yenching Journal of Chinese Studies
Peking, China
Institut de l'recherchesbiologiques de Perm
Perm, Russia
Die deutsche Universität am Prag
Prag, Czecho-slovakia
Deutscher naturwissenschaften-medizeschiner Verein für Böhmen
Prag, Böhmen
Société Royale des Sciences de Boheme
Prague, Bohemia
Kgl. Böhm Gesellschaft der Wissenschaften
Prague, Böhmen
Société Scientifique et Medicale de l'Ouest
Rennes, France
Naturforschend Verein zu Riga
Riga, Russia
Archivos de Hygiene
Rio de Janeiro, Brazil
Instituto Oswaldo Cruz
Rio de Janeiro, Brazil
Brazilian Coal Commission
Rio de Janeiro, Brazil
Museu Nacional do Rio de Janeiro
Rio de Janeiro, Brazil
Jardin Botanico
Rio de Janeiro, Brazil
L'Ingegneuria Ferroviaria
Rome, Italy
Rassegna Italiana
Piazza Mignanelli—25, Rome, Italy
Naturforschenden Gesellschaft
Rostock, Germany
Freunde der Naturgeschichte
Rostock, Germany
Accademia Roveretana degla Aguata
Roverto

Soc. Amis des Sciences Naturelles
Rouen, France
Ryojun College of Engineering
Port Arthur, S. Manchuria, Ryojun, China
Instituto di Biologia Marina del Tureno
San Bartolomeo, (Cagliari)
La Oficinia Para la Defensa Agricola
San Jacínta, Mexico
Porto Rico Journal of Public Health & Tropical Medicine
San Juan, Porto Rico
Inspeccion de Ensenanza i Fomento Agricolas
Santiago, Chile
La Universidad de Chile
Santiago, Chile
Sapporo Natural History Society
Sapporo, Japan
Journal of the Faculty of Science
Sapporo, Japan
Universita di Sassari
Sassari, Italy
China Journal of Sciences and Arts
Shanghai, China
Schweizerische Naturforschende Gesellschaft
Solothurn, Switzerland
Naturforschenden Gesellschaft
Solothurn, Switzerland
Sveriges Geologiska Undersökning
Stockholm, Sweden
Kongl. Svenska Vetenskapsakademiens
Stockholm, Sweden
Le Prix Nobel
Stockholm, Sweden
Comité Géologique
St. Petersburg, Russia
De l'Institut des Mines de l'Imperatice Catherine II
St. Petersburg, Russia
Die Kaiserliche Mineralogische Gesellschaft
St. Petersburg, Russia
Russisch-Kaiserliche Mineralogische Gesellschaft
St. Petersburg, Russia
Musée Geologique Pierre le Grand près l'Academie Imperiale des Sciences
St. Petersburg, Russia
Geological Survey of New South Wales
Sydney, New South Wales
Australian Museum
Sydney, New South Wales
Linnean Society of New South Wales
Sydney, New South Wales

Naturforscher-Gesellschaft
Tartu, Esthonia
Botanical Institute, Tokyo Univ. of Literature & Science
Koishikawa, Tokyo, Japan
Geographical Institute, Tokyo Univ. of Literature and Science
Koishikawa, Tokyo, Japan
Paleontological Society of Japan, Imperial Univ. of Tokyo
Tokyo, Japan
Staatsuniversität
Tomsk, Russia
Canadian Institute
Toronto, Canada
Accad. Reale delle Scienze di Torino
Torino, Italy
Annali di Freniatria e Scienze Affini
Torino, Italy
Archivio di Psichiatria, Neuropatologia Antropologia Criminale e Medicina Legale
Torino, Italy
Scienze Medicale
Torino, Italy
Musei di Zoologia ed Anatomia comparata
Torino, Italy
Tromsö Museums
Tromsö, Norway
Academie des Sciences d'Ukraine
Ukraine, Russia
K. Svenska Vetenskapsakademien i Stockholm
Uppsala and Stockholm, Sweden
K. Vetenskapsakademien Nobelinstitut
Uppsala and Stockholm, Sweden
Der Köngl. Societat der Wissenschaften zu Upsala
Upsala, Sweden
Kungl. Universitetets Bibliotek
Upsala, Sweden
Regia Societas Scientarum Upsaliensis
Upsala, Sweden
Rijks-Universiteit te Utrecht
Utrecht, Netherlands
Die Kaiserliche Akademie der Wissenschaften
Wien, Austria
Der Zoologisch Botanische Gesellschaft in Wien
Wien, Austria

UNITED STATES

New York Education Department
Albany, N. Y.

Education Department of University of State of N. Y.
Albany, N. Y.
University of New York, State Museum
Albany, N. Y.
New York Education Department, State Library Report
Albany, N. Y.
University of New Mexico
Albuquerque, New Mex.
Iowa State College of Agriculture and Mechanic Arts
Ames, Iowa
Massachusetts State College, Massachusetts Agricultural Experiment Station
Amherst, Mass.
University of Michigan
Ann Arbor, Mich.
Michigan Academy of Science
Ann Arbor, Mich.
University of Texas
Austin, Tex.
Texas Academy of Science
Austin, Tex.
American Chemical Journal
Baltimore, Md.
Johns Hopkins University
Baltimore, Md.
Johns Hopkins Hospital
Baltimore, Md.
National Academy of Sciences
Baltimore, Md., and Boston, Mass.
Maryland Geological Survey, Johns Hopkins Univ.
Baltimore, Md.
American Academy of Arts and Sciences, Johns Hopkins University
Baltimore, Md.
American Journal of Anatomy
Baltimore, Md.
The American Journal of Insanity
Baltimore, Md.
Louisiana Geological Survey, (Experimental Station)
Baton Rouge, La.
Modern Medicine
Battle Creek, Mich.
University of California
Berkeley, Calif.
Hilgardia
Publications in Economics
Publications in Agricultural Science
Department of Zoology
Department of Geology
California Institute of Technology
Berkeley, Calif.

Institute of Research, Lehigh University
Bethlehem, Pa.
Geological Survey of Virginia
Blacksburg, Va.
Indiana University
Bloomington, Ind.
American Academy of Arts and Sciences
Boston, Mass.
The American Physiological Society
Boston, Mass.
Boston Society of Natural History
Boston, Mass.
Massachusetts Institute of Technology
Boston, Mass.
The Journal of Medical Research
Boston, Mass.
University of Colorado
Boulder, Colo.
Montana Agricultural College
Bozeman, Mont.
Sanitarium Directory of New England and Middle States
Brooklyn, N. Y.
Brooklyn Medical Journal
Brooklyn, N. Y.
Buffalo Society of Natural Sciences
Buffalo, N. Y.
Museum of Comparative Zoology at Harvard
Cambridge, Mass.
Gulf Biologic Station
Cameron, La.
West Texas State Teachers College
Canyon, Texas
Elisha Mitchell Scientific Society
Chapel Hill, N. C.
Chicago Academy of Sciences
Chicago, Ill.
Field Columbian Museum
Chicago, Ill.
John Crerar Library
Chicago, Ill.
The Monist
Chicago, Ill.
University of Chicago
Chicago, Ill.
Journal of Comparative Neurology and Psychology
Journal of Geology
Oriental Institute, University of Chicago
Chicago, Ill.

The Chicago Academy of Sciences
Chicago, Ill.
Mycological Notes
Cincinnati, Ohio
Mycological Writings
Cincinnati, Ohio
Lloyd Library
Cincinnati, Ohio
University of Cincinnati, Basic Science Research Laboratories
Cincinnati, Ohio
Cincinnati Society of Natural History
Cincinnati, Ohio
Cincinnati Junior Society of Natural Sciences
312 Broadway St., Cincinnati, Ohio
Journal of Entomology and Zoology, Pomona College
Claremont, Calif.
Lakeside Hospital
Cleveland, Ohio
Western Reserve University
Cleveland, Ohio
Colorado College Publications
Colorado Springs, Colo.
University of Missouri
Columbia, Mo.
Ohio State Academy of Science
Columbus, Ohio
American Society of Mechanical Engineers
Columbus, Ohio
The Ohio State University Naturalist
Columbus, Ohio
Ohio Archaeological and Historical Society
Columbus, Ohio
Ohio Biological Society
Columbus, Ohio
Geological Survey of Ohio
Columbus, Ohio
The Ohio Journal of Science
Columbus, Ohio
Ohio Sanitary Bulletin, Ohio Board of Health
Columbus, Ohio
Columbus Horticulture Society
Columbus, Ohio
Commission of Statistics
Columbus, Ohio
Ohio Educational Monthly
Columbus, Ohio
Ohio Dairy and Food Commissioner
Columbus, Ohio

Ohio Medical University
Columbus, Ohio
National Municipal Review
Concord, N. H.
Association of Economic Entomologists
Concord, N. H.
Field and Laboratory, Southern Methodist University
Dallas, Tex.
Davenport Academy of Sciences
Davenport, Ia.
Iowa Academy of Science
Des Moines, Ia.
Detroit Medical Journal
Detroit, Mich.
American Academy of Medicine
Easton, Pa.
American Chemical Society
Easton, Pa.
University of Oregon
Eugene, Ore.
University of Arkansas
Fayetteville, Ark.
Colorado School of Mines
Golden, Colo.
University of North Dakota
Grand Forks, N. Dak.
Denison University
Granville, Ohio (Bull. Sci. Lab.)
Geological and Natural History Survey
Hartford, Conn.
American Society for the Study of Alcohol and other Narcotics
Hartford, Conn.
Board of Agriculture and Forestry of Territory of Hawaii
Honolulu, Hawaii
Hawaiian Sugar Planters Association
Honolulu, Hawaii
Hawaiian Sugar Planters Association Experiment Station
Honolulu, Hawaii
United States Geological Survey
Honolulu, Hawaii
Butler University
Indianapolis, Ind.
Indiana Academy of Science
Indianapolis, Ind.
Department of Geology of Indiana
Indianapolis, Ind.
University of Iowa
Iowa City, Iowa

Purdue University, Agricultural Experiment Station
Lafayette, Ind.
The American Naturalist
Lancaster, Pa.
University of Kansas
Lawrence, Kans.
Journal of Philosophy, Psychology and Science
Lancaster, Pa.
Kentucky Academy of Science
Lexington, Ky.
Kentucky Geological Survey
Lexington, Ky.
Nebraska Geological Survey
Lincoln, Nebr.
University of Nebraska
Lincoln, Nebr.
Studies from the Zoological Laboratory
College of Agriculture Experiment Station
American Microscopical Society
Lincoln, Nebr.
Los Angeles Museum
Los Angeles, Calif.
Texas Technological College
Lubbock, Tex.
Randolph-Macon Woman's College
Lynchburg, Va.
University of Wisconsin
Madison, Wis.
Journal of Geography
Madison, Wis.
Wisconsin Survey of Geology and Natural History
Madison, Wis.
Wisconsin Academy of Science
Madison, Wis.
Kansas Academy of Science
Manhattan, Kans.
Tufts College
Medford, Mass.
Torrey Botanical Club, Columbia University
New York City, N. Y.
Torrey Botanical Club
Menasha, Wis.
Wisconsin Natural History Society, Public Museum
Milwaukee, Wis.
Janres-Bericht des Natur
The Wisconsin Archeologist
Minnesota Academy of Natural Sciences
Minneapolis, Minn.

Minnesota School of Mines
Minneapolis, Minn.
Research Publications of University of Minnesota, University of Minnesota
Minneapolis, Minn.
Geological and Natural History Survey of Minnesota, University of Minnesota,
Minneapolis, Minn.
University of Minnesota
Minneapolis, Minn.
University of Montana
Missoula, Mont.
Geological Survey of Alabama
Montgomery, Ala.
West Virginia University
Morgantown, W. Va.
Columbia University
Morningside Heights, N. Y.
Tennessee Academy of Science
Nashville, Tenn.
Essex County Hospitals for the Insane
Newark, N. J.
Connecticut Academy of Arts and Sciences
New Haven, Conn.
Contributions from Yale University
New Haven, Conn.
Louisiana Department of Conservation
New Orleans, La.
Psychological Bulletin
New York, N. Y.
The Journal of Mental Pathology
New York, N. Y.
The Journal of Nervous and Mental Disease
New York, N. Y.
New York Botanical Garden, Bronx Park
New York, N. Y.
American Museum of Natural History
New York, N. Y.
New York Academy of Sciences
New York, N. Y.
The Psychological Review
New York, N. Y.
American Electrician
New York, N. Y.
Electrochemical and Metallurgical Industry
New York, N. Y.
Science
New York, N. Y.
Secretary of State Publications
Norwalk, Ohio

Archaeological Institute of America
Norwood, Mass.
University of Notre Dame
Notre Dame, Ind.
Wilson Ornithological Club
Oberlin, Ohio
Oberlin College Laboratory
Oberlin, Ohio
Maine Agricultural Experiment Station
Orono, Me.
University of Maine
Orono, Me.
Academy of Natural Sciences
Philadelphia, Pa.
University of Pennsylvania
Philadelphia, Pa.
Contributions from Botanical Laboratory
Astronomical Series
Contributions from Zoological Laboratory
American Medicine
Philadelphia, Pa.
American Philosophical Society
Philadelphia, Pa.
Annals of Surgery
Philadelphia, Pa.
Medical Notes
Philadelphia, Pa.
Baker Chemical Company, The Chemical Analyst
Phillipsburg, N. J.
Publications of the Allegheny Observatory, University of Pittsburgh
Pittsburgh, Pa.
Carnegie Museum
Pittsburgh, Pa.
Portland Society of Natural History
Portland, Me.
Biological Department of Brown University
Providence, R. I.
Brown University
Providence, R. I.
Rhode Island School Reports
Providence, R. I.
State College of Washington
Pullman, Wash.
Bausch and Lomb Optical Company, The Educational Focus
Rochester, N. Y.
Eastman Kodak Company, Synthetic Organic Chemicals
Rochester, N. Y.
Rochester Academy of Science
Rochester, N. Y.

Augustana Library Publications
Rock Island, Ill.
School of Mines and Metallurgy, University of Missouri
Rolla, Mo.
San Diego Society of Natural History
San Diego, Calif.
Pacific Medical Journal
San Francisco, Calif.
California Academy of Sciences
San Francisco, Calif.
Recreational and Hiway Magazine, University of New Mexico
Sante Fe, New Mex.
University of Washington Engineering Experiment Station
Seattle, Wash.
Ohio State Board of Health
Springfield, Ohio
Missouri Botanical Garden Library, 2315 Tower Grove Ave.
St. Louis, Mo.
Washington University
St. Louis, Mo.
The Alienist and Neurologist
St. Louis, Mo.
Academy of Science of St. Louis
St. Louis, Mo.
Kansas Academy of Science
Topeka, Kans.
Rensselaer Polytechnic Institute
Troy, N. Y.
Tufts College
Mass.
University of North Dakota
University, N. D.
University of Alabama
University, Ala.
Illinois State Laboratory of Natural History
Urbana, Ill.
Illinois State Geological Survey
Urbana, Ill.
National Academy of Sciences
Washington, D. C.
Philosophical Society of Washington
Washington, D. C.
Smithsonian Institution
Washington, D. C.
Bureau American Ethnology
Board of Regents
Miscellaneous Collections
International Exchange Service
Bulletin of United States National Museum

Annals of Astrophysical Observatory
Contributions from United States Herbarium
Contributions to Knowledge
Carnegie Institution of Washington
Washington, D. C.
United States Department of Agriculture
Washington, D. C.
Bureau of Animal Industry
Division of Biological Survey
Division of Botany
Division of Chemistry
Bureau of Chemistry
Office of Experimental Stations
Bureau of Entomology
Alaska Agricultural Experiment Station
Porto Rico Agricultural Experiment Station
Farmers Bulletin
Office of the Secretary—Food Inspection Decision
Director of Forestry
Bureau of Forestry
Division of Forestry
Hawaii Agricultural Experiment Station
Office of Irrigation Inquiry
Library Bulletin
Division Ornithology and Mammalogy
Division of Publications
Bureau of Plant Industry
Office of Road Inquiry
Office of Public Roads
Office of Solicitor
Bureau of Soils
Bureau of Statistics
Weather Bureau
Botanical Division Section of Vegetable Pathology
Division of Agrostology
Bureau of Animal Industry
United States Department of Commerce and Labor
Washington, D. C.
Bureau of Standards
Coast and Geodetic Survey
Bureau of Manufacturers
Bureau of Fisheries
Bureau of the Census
Bureau of Foreign and Domestic Commerce
Bureau of Mines
Fish Commission
United States Department of Interior
Washington, D. C.
Geological Survey

Ethnological Survey Publications
Bureau of Mines
United States Patent Office
United States Department of the Treasury
Washington, D. C.
Public Health and Marine Hospital Service
Hygienic Laboratory
United States Bureau of Education
Washington, D. C.
Public Works Administration
Washington, D. C.
Marine Biological Laboratory
Woods Hole, Mass.
Woods Hole Oceanographic Institution
Woods Hole, Mass.
American Journal of Psychology
Worcester, Mass.
Baylor University
Waco, Tex.
Ohio Forestry Department
Wooster, Ohio

STATE AGRICULTURAL STATIONS*

Alabama Agricultural Experiment Station
Opelika, Ala.
University of Arizona Agricultural Experiment Station
Tucson, Ariz.
University of California Agricultural Experiment Station
Berkeley, Calif.
Connecticut Agricultural Experiment Station
Storrs, Conn.
Connecticut Agricultural Experiment Station
New Haven, Conn.
Delaware College Agricultural Experiment Station
Newark, Del.
Agricultural Extension Division, University of Florida
Gainesville, Fla.
Georgia Agricultural Experiment Station
Experiment, Ga.
Hawaii Agricultural Experiment Station
Honolulu, Hawaii
University of Idaho Agricultural Experiment Station
Moscow, Idaho
University of Illinois Agricultural Experiment Station
Urbana, Ill.
Purdue University, Agricultural Experiment Station
La Fayette, Ind.

* Arranged alphabetically by states.

State College of Agriculture
Ames, Iowa
Kansas State Agricultural College, Experiment Station
Manhattan, Kans.
Kansas State College, Engineering Experiment Station
Manhattan, Kans.
Kansas Legislative Council
Topeka, Kans.
Kentucky Agricultural Experiment Station
Lexington, Ky.
Louisiana Agricultural Experiment Station
Baton Rouge, La.
Maine Agricultural Experiment Station
Orono, Me.
Maryland Agricultural College
College Park, Md.
Massachusetts Agricultural Experiment Station
Amherst, Mass.
Michigan Agricultural College Experiment Station
East Lansing, Mich.
Michigan State College, Agricultural Experiment Station
East Lansing, Mich.
University of Minnesota Agricultural Experiment Station
St. Paul, Minn.
University of Missouri Agricultural Experiment Station
Columbia, Mo.
Montana State Agricultural Experiment Station
Bozeman, Mont.
University of Nebraska Agricultural Experiment Station
Lincoln, Nebr.
Nevada Agricultural Experiment Station
Carson City, Nev.
Nevada University Agricultural Experiment Station
Reno, Nev.
New Hampshire College Agricultural Experiment Station
Durham, N. H.
New Jersey Agricultural Experiment Station
New Brunswick, N. J.
New Mexico Agricultural Experiment Station
Santa Fe, New Mex.
New York Agricultural Experiment Station
Geneva, N. Y.
Cornell University, New York State Agricultural Experiment Station
Geneva, N. Y.
Dept. Agriculture and Markets of New York
Albany, N. Y.
North Carolina Department of Agriculture
Raleigh, N. C.

North Dakota Agricultural College Experiment Station
Fargo, N. D.
Ohio Agricultural Experiment Station
Wooster, Ohio
Ohio State University College of Agriculture
Columbus, Ohio
Pennsylvania State Department of Agriculture, Division of Zoology
Harrisburg, Pa.
Pennsylvania State College Agricultural Experiment Station
State College, Centre County, Pa.
Rhode Island Agricultural Experiment Station
Kingston, R. I.
South Dakota Agricultural College Experiment Station
Brookings, S. D.
University of Tennessee Agricultural Experiment Station
Knoxville, Tenn.
Texas Agricultural Experiment Station
College Station, Brazos County, Tex.
Utah Agricultural College Experiment Station
Logan, Utah
Vermont Agricultural Experiment Station
Burlington, Vt.
Virginia Truck Experiment Station
Norfolk, Va.
West Virginia University Agricultural Experiment Station
Morgantown, W. Va.
University of Wyoming Agricultural Experiment Station
Laramie, Wyo.

MAILING LIST*

Foreign

Royal Society of South Australia, Institute Building
Adelaide, South Australia
Société d'Études Scientifiques
Angers, France
Sekretariat, Universitätsbibliothek
Klingelbergstrasse 82, Basel, Switzerland
Amerika-Institut
Universitätsstrasse 7, Berlin, N. W., Germany
Pressische Akademie der Wissenschaften
Unter den Linden 38, Berlin, N. W. 7, Germany
Naturforschende Gesellschaft in Bern
Bern, Switzerland
Stadt-Bibliothek
Bern, Switzerland

* Arranged alphabetically according to geographical address.

Naturwissenschaftlicher Verein
Bremen, Germany
University of Queensland, The Library
Brisbane, Queensland, Australia
Bristol Naturalist's Society, The Museum and Art Gallery
Bristol, England,
L'Academie Royale des Sciences, des Lettres et des Beaux Arts de Belgique, Palais des Academies
Bruxelles, Belgium
Museo Nacional de Historia Natural
Casilla de Correo 470, Buenos Aires, Argentine
Sociedad Cientifica Argentina
Santa Fe 1145, Buenos Aires, Argentine Republic
R. Universita di Cagliari, Seminario della Facolta di Scienze
Cagliari, Italy
Institute Egyptien
Rue Cheikh Rihane, Cairo, Egypt
Universite Egyptiene
Cairo, Egypt
Cambridge Philosophical Society, New Museum
Cambridge, England
Lingnan Science Journal, Lingnan University
Canton, China
College de France, (Laboratoire de Zoologie & de Physiologie, Maritimes de Concarneau)
Concarneau, France
L'Academie Royale des Sciences et des Lettres de Denmark
Dantes Plads 35, Copenhagen V, Denmark
Naturforche Gesellschaft der Universität Dorpat
Dorpat, Estland, U. S. S. R.
Gesellschaft für Natur-und Heilkund, Bibliothek
Dresden, N. 6, Germany
Royal Dublin Society, Ball's Bridge
Dublin, Ireland
Royal Irish Academy
Dublin, Ireland
Edinburgh Geological Society, Synod Hall Bldgs.
Castle Terrace, Edinburgh, Scotland
Royal Society of Edinburgh
22 George St., Edinburgh, Scotland
University of Alberta
Edmonton, Alberta, Canada
Lo Sperimentale
Firenze, Italy
Senckenbergische Bibliothek
Posts Chekkonto Frankfurt, a.M. 20322, Germany
Société Fribourgeoise des Sciences Naturelles, Bibliotheque Cantonale et Universitaire
Fribourg, Switzerland

Société de Physique et d'Histoire Naturelle, Bibliotheque publique
Geneva, Switzerland
Deutscher Verein zum Schutze der Vogelwelt
Gera (Rauss), Germany
Oberhessische Gesellschaft für Natur- und Heilkunde
Birmarckstrasse 3F, Giessen (Lahn), Germany
The Natural History Society of Glasgow, Mitchell Library
Glasgow, Scotland
Naturwissenschaftlicher Verein für Steiermark, Universitäts-Bibliothek
Graz, Austria
Nova Scotian Institute of Science
Halifax, Nova Scotia, Canada
Bibliothek der Kaiserl. Leop. Carol. Akademie der Naturforscher
Friedrich strasse 50a, Halle a Saale, Germany
Naturforschende Gesellschaft
Halle-an-der-Saale (Prussia), Germany
Naturwissenschaftlicher Verein
Jungiusstrasse 6, Hamburg, Germany
Universidad de la Habana
Havana, Cuba
Naturhistorisch-Medicinischer Verein, Universitätsbibliothek
Heidelberg (Baden), Germany
Robert College
Istanbul, Turkey
Library, Allukranian Academy of Sciences
Korolenko Str. 58-a, Kief, Ukraine, U. S. S. R.
Kief Society of Naturalists
Kief, Ukraine, U. S. S. R.
Bibliothek der Cölner Akademie für praktische Medizin
Köln am Rhein (Cologne), Germany
Universitäts u. Stadtbibliothek
Claudiusstrasse 1, Köln am Rhein, Germany
Königliche Physikalisch-ökonomische Gesellschaft
Königsberg, Prussia, Germany
Dirrecion Nacional de Estadistica y Estudios Geograficos
La Paz, Boliva, S. A.
Biblioteca de la Facultad de Quimica y Farmacia
Calle 1 esquina 47, La Plata, Argentina
Facultad de ciencias fisicomatematicas, Comision de Publicaciones
Avenida 1, esquina 47, La Plata, Argentina
Universidad Nacional de La Plata
La Plata, Argentina
Societe Scientifique de Chevtchenko
Lemberg, Austria
Central Teological Library (of the Teological Service)
W. O. Sredny pr., F2-C, Leningrad, U. S. S. R.
Comite Geologique
Leningrad, U. S. S. R.

Institut des Mines
Vass. Ostrov, 21 Linie N2, Leningrad 26, U. S. S. R.
Societe Russe de Mineralogie
Wassily Ostrow 21, Linie N2, Leningrad 26, U. S. S. R.
Geological Survey of Great Britain
London, England
General Library, British Museum (Natural History)
Cromwell Road, London S. W. 7, England
The Science Library, The Science Museum
South Kensington, London S. W. 7, England
B. F. Stevens & Brown Ltd.
New Ruskin House, 28–30 Little Russel St., W. C. I, London, England
Patent Office Library
25 Southampton Buildings, London, W. C. 2, England
The Royal Society
London, England
The University Library
Königl. Universitets-Bibliotheke, Lund, Sweden
Real Academia de Ciencias Exactas, Fisicas y Naturales
Madrid, Spain
Manchester Literary and Philosophical Society
36 George St., Manchester, England
Philippine Library and Museum
Manila, Philippine Islands
Gesellschaft zur Beförderung der Gesammten Naturwissenschaften
Am Plan 3, Marburg, Prussia, Germany
Royal Society of Victoria
Victoria Street, Melbourne, Australia
Biblioteca del Instituto de Biologia
Chapultepec (Casa del Lago), Mexico, D. F., Mexico
Library of the Instituto de Geologia
6ª Calle del Cipres #176, Mexico, Mexico
Sociedad Cientifica "Antonio Alzate", Academia Nacional de Ciencias
Mexico, Mexico
Sociedad Mexicana de Geografia y Estadistica
1ª de la Academia 9, Mexico, Mexico
Universidad de Mexico, Revista
Mexico City, Mexico
Universidad Nacional Autonoma, Jefe de Seccion Editorial
Justo Sierra #16, Mexico, D. F., Mexico
The Public Library, c/o U. S. S. R. Society for Cultural Relations with Foreign Countries
Minsk (Russia), U. S. S. R.
Sr. Inspector Nacional de Instruccion Primaria, Annales de Instruccion Primaria
Montevideo, Uruguay
Museo Nacional de Montevideo
Montevideo, Uruguay
Bibliothek der Bayerische Akademie der Wissenschaften
Neuhauserstr 51, München, (Bavaria) Germany

Société des Sciences de Nancy
Nancy, France
The Geological Society of China, Shui Ching Tai
Chukiang Road, Nanking, China
Annali di Neurologia
Naples, Italy
Revista di Neurologia, Clinica Neurologica di Napoli
Naples, Italy
The Medical Institute
Omsk, U. S. S. R.
Library, Geological Survey of Canada
Ottawa, Canada
Royal Society of Canada
Ottawa, Ontario, Canada
Société zoologique de France
195, Rue Saint-Jacques, Paris (V), France
Fan Memorial Institute of Biology
Peiping, China
Yenching University Library
Peking, China
Biological Research Institute of Perm
Perm, Zaimka, U. S. S. R.
"Lotos," Naturwissenschaftlich-Medicinischer, Verein für Böhmen
Praha, I, Bohemia, Weinberggasse 3, Czechoslovakia
Masaryk Academy of Work
Praha I, Staromestske N. 16, Czechoslovakia
Société Royale des Sciences et des Lettres de Boheme
Praha I, Klementinum, Czechoslovakia
Société Scientifique de Bretagne
Place Pasteur, Rennes, France
Society of Naturalists
Palasta 4, Riga, Latvia
Museo Nacional
Rio de Janeiro, Brazil
L'Ingegneria Ferroviaria
Roma, Italy
Naturforschende und Medizinische Gesellschaft
Rostock, Germany
Société des Amis des Sciences Naturelles
Rouen, France
Secretaria de Agricultura y Formento
San Jacinto, Mexico
La Universidad de Chile
Santiago, Chile
Sapporo Natural History Society
Sapporo, Japan
Universita di Sassari
Sassari, Italy

Naturforschende Gesellschaft
Solothurn, Switzerland
K. Vetenskaps-Akademiens, Bibliotek
Stockholm 50, Sweden
Sveriges Geologiska Undersökning
Stockholm 50, Sweden
Australian Museum
College St., Sydney, New South Wales, Australia
Linnean Society of New South Wales
Gloucester & Essex Sts., Sydney, New South Wales
University of Sydney, Librarian, Fisher Library
Sydney, N. S. W., Australia
Tartu Ulikooli juures olen Loodusuuryat Gelts
Via 46, Tartu, Estonie, U. S. S. R.
Museo di Zoologia e di Anatomia Comparata della R. Universita
Torino, Italy
Reale Accademia delle Scienze
Via Maria Vittoria 3, Torino, Italy
Royal Canadian Institute
198 College St., Toronto 2, Canada
Kungl. Universitets Bibliotak
Uppsala, Sweden
Library of the University
Utrecht, Netherlands
Victoria University College Library
Wellington, New Zealand
Akademie der Wissenschaften
Universitätsplatz 2, Wien, I, Austria
Zoologisch-Botanische Geselschaft
Wien (Osterreich), III, Mechelgasse 2, Austria

UNITED STATES

New York State Museum
Albany, N. Y.
State Library, Serials Section
Albany, N. Y.
University of New Mexico Library
Albuquerque, N. Mex.
Massachusetts Agricultural Experiment Station
Amherst, Mass.
University of Michigan, General Library
Ann Arbor, Mich.
University of Texas, Bureau of Economic Geology
Austin, Tex.
Library of Johns Hopkins Hospital
North Broadway, Baltimore, Md.
Maryland Geological Survey
Baltimore, Md.

School of Geology, Louisiana State University
Baton Rouge, La.
The University of California Library
Berkeley, Cal.
Lehigh University, The Library
Bethlehem, Pa.
Indiana University Library
Bloomington, Ind.
American Academy of Arts and Sciences
28 Newbury St., Boston, Mass.
Boston Public Library
Copley Square, Boston, Mass.
Boston Society of Natural History
234 Berkeley St., Boston, Mass.
University of Colorado Library
Boulder, Colo.
Library of New York Botanical Garden
Bronx Park, New York, N. Y.
Research Library, Buffalo Museum of Science
Humboldt Park, Buffalo, N. Y.
Billings Library, University of Vermont
Burlington, Vt.
Massachusetts Institute of Technology Library
Cambridge, Mass.
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Cambridge, Mass.
Elisha Mitchell Scientific Society
Chapel Hill, N. C.
The John Crerar Library
86 E. Randolph St., Chicago, Ill.
University of Chicago Libraries
Chicago, Ill.
Field Museum of Natural History
Chicago, Ill.
University of Cincinnati Library
Cincinnati, Ohio
Cincinnati Society of Natural History
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Lloyd Library
309 W. Court St., Cincinnati, Ohio
Pomona College, Department of Biology
Claremont, Calif.
Cleveland Public Library
325 Superior Ave., N.E., Cleveland, Ohio
Western Reserve University Libraries
Cleveland, Ohio
Research Department, National Lamp Works of General Electric Co.
Nela Park, Cleveland, Ohio

University Club
Cleveland, Ohio
Colorado College, Coburn Library
Colorado Springs, Colo.
University of Missouri General Library
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The Geological Survey of Ohio
Columbus, Ohio
The Ohio State Library, State Capitol
Columbus, Ohio
Ohio State University Library
Columbus, Ohio
University Club
Columbus, Ohio
Davenport Academy of Sciences
Davenport, Iowa
Ohio Wesleyan University, Slocum Library
Delaware, Ohio
Iowa Academy of Sciences, c/o State Library
Des Moines, Iowa
University of Oregon Library
Eugene, Ore.
Northwestern University Library
Evanston, Ill.
Kentucky Geological Survey
Frankfort, Ky.
Library, New York State Agricultural Experiment Station
Geneva, N. Y.
Colorado School of Mines Library
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University of North Dakota Library
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Dartmouth College
Hanover, N. H.
Connecticut State Library
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Experiment Station of the Hawaiian Sugar Planters Association
Honolulu, Hawaiian Islands
Indiana Academy of Sciences
Indianapolis, Ind.
University of Iowa, The Library
Iowa City, Iowa
Cornell University Library
Ithaca, N. Y.
Library, Purdue University, Agricultural Experiment Station
Lafayette, Ind.
Geological Survey Division
Lansing, Mich.

University of Kansas, Department of Geology
Lawrence, Kans.
Science Bulletin, Watson Library, University of Kansas
Lawrence, Kans.
Kentucky Academy of Science, Experiment Station
Lexington, Ky.
University of Kentucky Library
Lexington, Ky.
University of Nebraska Library
Lincoln, Neb.
The Library, University of California at Los Angeles
Los Angeles, Calif.
Los Angeles Museum, Exposition Park
Los Angeles, Calif.
The University of Wisconsin Library
Madison, Wis.
Library Kansas State College of Agriculture
Manhattan, Kans.
Public Museum of Milwaukee
Milwaukee, Wisc.
University of Minnesota (Library)
Minneapolis, Minn.
State Geological Survey
401 Seventh Avenue, Nashville, Tenn.
Tennessee Academy of Science
Nashville, Tenn.
Vanderbilt University Library, College Hall
Nashville, Tenn.
The Library, Muskingum College
New Concord, Ohio
Connecticut Academy of Arts and Sciences
New Haven, Conn.
Conn. Agricultural Experiment Station
New Haven, Conn.
Peabody Museum, Yale University
New Haven, Conn.
American Museum of Natural History
77th St. and Central Park West, New York, N. Y.
Columbia University Library
New York, N. Y.
Geological Library, Columbia University
New York, N. Y.
The Library, New York Academy of Medicine
2 East 103rd St., New York, N. Y.
New York Academy of Sciences
West 77th St. and Central Park West, New York, N. Y.
New York Public Library
Fifth Ave. and 42nd St., New York, N. Y.

Ohio Society of New York
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Torrey Botanical Club, Columbia University
New York, N. Y.
University of Oklahoma Library
Norman, Okla.
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Notre Dame, Ind.
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Oberlin, Ohio
University of Maine Library
Orono, Me.
Miami University Library
Oxford, Ohio
California Institute of Technology
The Library, Pasadena, Calif.
Academy of Natural Sciences of Philadelphia
Philadelphia, Pa.
American Philosophical Society
Philadelphia, Pa.
Biological Abstracts, University of Pennsylvania
Philadelphia, Pa.
Carnegie Museum
4400 Forbes St., Pittsburgh, Pa.
Portland Society of Natural History
22 Elm St., Portland, Me.
The Library, Princeton University
Princeton, N. J.
Anatomical Laboratory, Brown University
Providence, R. I.
University of Nevada Library
Reno, Nev.
Rochester Academy of Science, Rush Rhees Library
Rochester, N. Y.
School of Mines and Metallurgy, The Library
Rolla, Mo.
San Diego Society of Natural History, Natural History Museum
Balboa Park, San Diego, Calif.
California Academy of Sciences,
Golden Gate Park, San Francisco, Calif.
Academy of Science of St. Louis, c/o St. Louis Public Library
St. Louis, Mo.
Library of Missouri Botanical Gardens
2315 Tower Grove Ave., St. Louis, Mo.
Washington University, The Library
St. Louis, Mo.

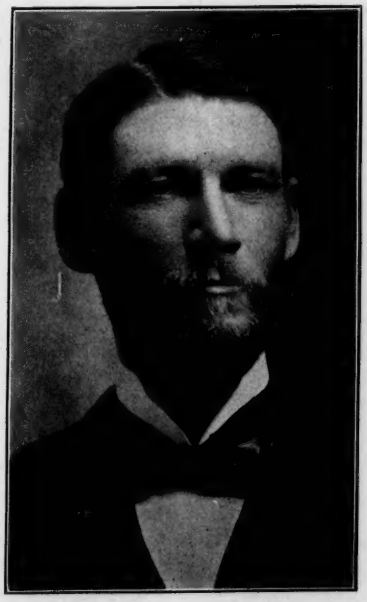
University of Washington Library
Seattle, Wash.
Syracuse University Library
Syracuse, N. Y.
Tufts College Library
Tufts College, Mass.
Virginia Geological Survey
Box 1428, University, Va.
Illinois State Natural History Survey
Urbana, Ill.
University of Illinois Library, Exchange Division
Urbana, Ill.
Library of Congress
Washington, D. C.
Library, Smithsonian Institution
Washington, D. C.
The Philosophical Society of Washington
Washington, D. C.
Library, United States Department of Agriculture
Washington, D. C.
The Library of the United States Geological Survey
Washington, D. C.
United States National Museum, Smithsonian Institution
Washington, D. C.
Antioch College
Yellow Springs, Ohio

FIFTY-YEAR SUMMARY

JOURNAL OF SCIENTIFIC LABORATORIES OF DENISON UNIVERSITY

VOLUME	EDITORS	YEARS	PAGES	PLATES	FIGURES
1	C. L. Herrick	1885	188	15	5
2	C. L. Herrick and A. D. Cole	1887	176	15	2
3	C. L. Herrick	1888	138	13	—
4	C. L. Herrick	1889–9	176	15	—
			678		
5	W. G. Tight	1890	96	21	—
6	W. G. Tight	1891–2	94	12	—
7	W. G. Tight	1892	104	1	—
8	W. G. Tight	1893–4	114	10	9
9	W. G. Tight	1895–7	72	13	5
10	W. G. Tight	1897	90	26	—
11	W. G. Tight and W. W. Stockberger	1898–1902	273	62	1
			843		
12	W. W. Stockberger and T. L. Watson	1902–4	230	14	26
13	C. W. Chamberlain	1905–7	166	13	53
			396		
14	Frank Carney	1908–9	442	11	90
15	Frank Carney	1910	100	—	—
16	Frank Carney	1910–1	423	13	49
17	Frank Carney	1912–4	487	29	9
18	Frank Carney	1915–6	378	23	11
			1830		
19*	K. F. Mather	1919–21	329	38	31
20	K. F. Mather	1922–4	383	51	18
			712	395	309
21	W. C. Ebaugh	1925–6	404	53	34
22	W. C. Ebaugh	1927	193	26	7
23	W. C. Ebauth	1928	355	85	16
24	W. C. Ebaugh	1929	427	68	17
25†	W. C. Ebaugh	1930	299	60	12
26‡	W. C. Ebaugh	1931	250	71	—
27	W. C. Ebaugh	1932	136	37	1
28	W. C. Ebaugh	1933	248	2	32
29	W. C. Ebaugh	1934	238	42	7
30	W. C. Ebaugh	1935	303	38	8
			2853	482	134
Total			7312	877	443

* Except Arts. 9–12, May, 1920; W. C. Ebaugh, Editor.
† Except Arts. 6–7, Dec., 1930; F. J. Wright, Editor.
‡ Except Art. 1, Apr., 1931; A. W. Lindsey, Editor.

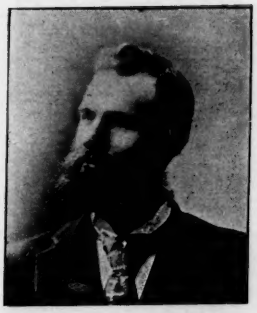


C. L. HERRICK
Editor 1885–1889

Herrick, Clarence Luther, president Univ. of New Mex.; b. Minneapolis, June 21, 1858; s. Rev. Henry N. H.; grad. Univ. of Minn., 1880 (M.S., 1882; Ph.D., 1898); m. June 21, 1883, Alice Keith. Studied at Leipsig and Berlin; became, consecutively, instr. botany, Univ. of Minn. (served on geol. survey of Minn.); prof. natural history, Denison Univ.; prof. biology, Univ. of Cincinnati, Univ. of Chicago, Denison Univ.; assoc. editor Am. Geologist; editor bulls. of Denison Univ.; editor-in-chief Jour. of Comparative Neurology. Author Mammals of Minnesota; Entomostraca of Minnesota; Waverly Group of Ohio; also about 200 papers on neurol., geol. and psychol. subjects. Address, Albuquerque, N. Mex. —*From Who's Who in America*, 1901–1902, page 527. (d. 1904.)

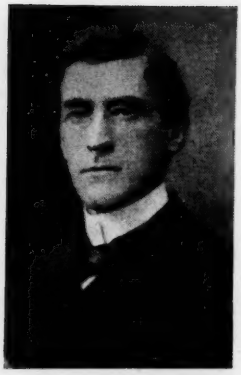
A. D. COLE
Editor 1887

Cole, Prof. Alfred D(odge), Ohio State University, Columbus, Ohio. **Physics.* Rutland, Vt., Dec. 18, 61. A. B. Brown, 84, A.M., 87; Hopkins, 84–85; summer sch., Harvard, 87; Berlin, 94–95, 13; summer sch., Cornell, 97; Chicago, summers, 98, 99, 00, 04. Instr. physics and chem., Denison, 85–87, acting prof., 87–88, prof., 88–01; *physics*, Ohio State, 01–07 Vassar, 07–08; *prof. and head of dept., Ohio State, 08–* Prof. physics, Chicago, summer, 04; trustee, Denison, 01–07, 11–; war work, U. S. N. Lab. and Bur. Standards, summers, 17, 18. A.A. (sec'y, B, 06–11, v. pres., 13–140; Physical Soc. (sec'y, 13–17, ed. board, 18–20; Radio Eng; Ohio Acad. Electric oscillation; electric waves; capillary electrometer; impact excitation; infrared radiation; electron relays.—From *American Men of Science*, third edition, page 137. (d.11/30/28.)



W. G. TIGHT
Editor 1890–1902

Tight, William George, educator; b. Granville, Ohio, Mar. 12, 1865; s. George H. and Thalia Ann (French) T.; grad. Denison Univ., B.S., 1886, M.S., 1887; Ph.D., Univ. of Chicago, 1901; m. Arabella Guy, Newark, Ohio. Was prof. geology, Denison Univ., 14 yrs.; now pres. and prof. geology Univ. of New Mexico. Mem. (past pres.) Ohio State Acad. Science; 10 yrs. permanent sec. Denison Scientific Assn.; fellow A. A. A. S., Geol. Soc. of America (pres. Cordilleran Section, 1905); mem. N. Nex. Acad. Sci. (ex-sec.). Contb'r to bulls. of survey and author of Professional Paper No. 13; Brief Geological History of New Mexico, in Anderson's History; New Mexico Supplement to Frye's geography. Address, Albuquerque, N. Mex.—From *Who's Who in America*, 1908–1909, page 1890. (d. 1910.)



W. W. STOCKBERGER
Editor 1902–1904

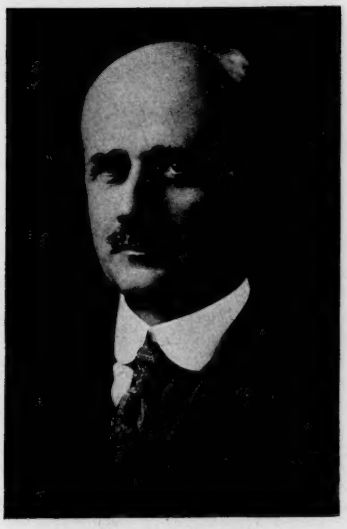
Stockberger, Dr. W(arner) W., U. S. Department of Agriculture, Washington, D. C. *Botany.* Croton, Ohio, July 10, 72. B.S., Denison, 02; Ph.D., George Washington, 07. Sch. supt., Ohio, 95–97; asst. science, Denison, 97–01, instr. bot., 01–03; expert in histol., *bur. plant indust., U. S. Dept. Agr.*, 03–09, pharmacognosist, 09–10, physiologist, 10–13, *in charge drug, poisonous and oil plant investigations, 13—, departmental director personnel and business admin., 25–* Asst. Sec'y, Pharmaceut. Convention, 20–30. A.A.; Pharmaceut. Asn.; hon. mem. Oil Chemists Soc.; Bot. Soc. Wash. (pres., 12). Pharmacognosy; drug plant culture in America; poisonous plants; new oil-seed crops; variation and heredity.—From *American Men of Science*, fifth edition, pages 1073–1074.

T. L. WATSON
Editor 1902–1904

Watson, Prof. Thomas L(eonard), Charlottesville, Va. **Geology.* Chatham, Va., Sept. 5, 71. Grad., Va. Agr. and Mech. Col., 90, M.S., 93; Virginia, 91; fellow, Cornell, 96–97, Ph.D., 97. Asst. chemist, Va. Exp. Sta., 90–95; instr. geol., Va. Agr. and Mech. Col., 91–95; asst. state geologist, Ga. Geol. Surv., 98–01; prof. geol., Denison, 01–04; Va. Polytech. Inst., 04–07; econ. geol., *Virginia*, 07–10, *head prof., schools of geol., 10–; director and state geologist, Va. Geol. Surv., 08–* Mem., sixth Peary arctic exped. to N. Greenland; research work, U. S. Nat. Museum, 97, 98; asst. geologist, Ind. Geol. surv., summer, 97; Ga. Geol. Surv., 98–01, geologist, 02; N. C. Geol. Surv., 03; asst. geologist, U. S. Geol. Surv., 03– A.A. (mem. committee of one hundred, scientific research); Geol. Soc. (councilor, 15–17); Min. Eng. (men. committee on war minerals); Mineral. Soc.; Soc. Econ. Geol.; Seismol. Soc.; Ass. State Geol. (sec'y); Wash. Geol. Soc.; Wash. Acad. Economic geology and petrography; geology of the rarer minerals; petrography of the southeastern Atlantic States.—From *American Men of Science*, third edition, page 720. (d. 1924.)

C. W. CHAMBERLAIN
Editor 1905–1907

Chamberlain, Dr. C(lark) W(ells), Michigan State College, East Lansing, Mich. *²*Physics*. Litchfield, Ohio, Oct. 29, 70. A.B., Denison, 94; fellow, Chicago, 99–00; Columbia, 08–09, Adams fellow, 09–11, Ph.D., 10; LL.D., McMinnville, 22; Cambridge, 25–26. Instr. physics and math., Western Reserve Acad., 94–97; prof. physics and astron., Colby Col., 00–01; physics, Denison, 01–08; Vassar Col., 08–13; pres. and prof. *physics*, Denison, 13–27; assoc. prof. and *prof.*, *Mich. State Col.*, *27–* Silver medal, Jamestown Expos., 07. A.A.; Physical Soc.; Inst. Social Sci.; Asn. Am. Cols. (pres., 23); Ohio Col. Asn. (pre., 22). A compound interferometer; the radius of molecular attraction; achromatism of interference; the diffractometer; a spectroscope of high resolving power; the relative motion of the earth and ether; the Lorentz-Fitzgerald effect; recording interferometer; application of resonance to interference phenomena.—From *American Men of Science*, fifth edition, page 188.



FRANK CARNEY
Editor 1908–1916

Carney, Dr. Frank, Baylor University, Waco, Texas. *Geology, Geography.* Watkins, N. Y., March, 15, 68. A.B., Cornell, 95, Ph.D., 09. Instr., Starkey Sem., N. Y., 87–90, prin., 94–95; prof. math. and languages, Keuka Col., 95–00; v. prin., high sch., N. Y., 01–04; prof. geol. and geog., Denison, 04–17; chief geologist, Nat. Ref. Co., 17–24, in charge land dept., 24–29; *prof. geol. and geog., Baylor,* 29– Acting prof., Michigan, 13–14; asst. geologist, Ohio Geol. Surv., 07–17. Summers, instr., Cornell, 01–04; 14–16; prof., Virginia, 09–11; Chicago, 12. A.A.; fel. Geol. Soc.; Asn. Geog.; Asn. Petrol. Geol.; Soc. Econ. Paleont. and Miner. Physiography; glacial geology; stream diversion; metamorphism of glacial drift; raised beaches; glacial lakes of northern Ohio; geographic influences in Ohio. —From *American Men of Science,* fifth edition, page 177. (d. 12/13/34.)

K. F. MATHER
Editor 1919–1924

Mather, Prof. Kirtley F(letcher), Harvard University, Cambridge, Mass. ***Physiography, Geology.* Chicago, Ill., Feb. 13, 88. B.S., Denison, 09; Sc.D., 29; Ph.D., Chicago, 15. Instr. and asst. prof. geol., Arkansas, 11–14; assoc. prof., Queen's (Can.), 15–17, prof. paleont., 17–18; geol., Denison, 18–24; assoc. prof. physiog., *Harvard*, 24–27, *prof. geol., 27–* Junior geologist, asst. geologist, assoc. geologist and geologist, U. S. Geol. Surv., 11-; petrol. geologist, Bolivia and Argentina, 19–20. Chairman ed. cmt., Sci. Book Club. Trustee, Children's Museum, Boston. A.A. (sec'y, E, 29–); Geol. Soc.; Asn. Petrol. Geol.; Paleont. Soc.; Seismol. Soc.; Min. and Metal. Eng.; Geophys. Union; Am. Acad.; Ohio Acad. (pres., 23); fel. Royal Geog. Soc. Quaternary geology of San Juan Mountains, Colorado; geology of the alaska peninsula; oil and gas resources of Oklahoma, Kentucky, Colorado, the Maritime Provinces and Bolivia; the physiography of North and South America; geophysical methods in geologic mapping; earthquakes in New England.—From *American Men of Science*, fifth edition, page 750.

F. J. WRIGHT
Editor December, 1930

Wright, Prof. Frank J(ames), Granville, Ohio. *Physiography.* Bridgewater, Va., Nov. 22, 88. A.B., Bridgewater Col., 08; A.M., Virginia, 11; Ph.D., Columbia, 18. Prof. Geol. and biol., Bridgewater Col., 11–16; assoc. *geol.*, Bryn Mawr Col., 18; *Prof.*, Bridgewater Col., 19–24; *Denison, 24–* From field asst. to asst. geologist, Va. Geol. Surv., 12–24; visiting assoc., Columbia, 23–24. Summer, instr., Columbia, 18, 20– Walker prize, Boston Soc. Nat. Hist., 22; A. Cressy Morison prize, N. Y. Acad. Sciences, 31. A.A.; Geol. Soc.; Asn. Geog.; N. Y. Acad.; Ohio Acad. (v. pres. 30). Physiography of Upper James River Basin; the southern Appalachians.—From *American Men of Science*, fifth edition, page 1238.

A. W. LINDSEY
Editor April, 1931

Lindsey, Dr. A(rthur) W(ard), Granville, Ohio. *Biology, Entomology.* Council Bluffs, Iowa, Jan. 11, 94. A.B., Morningside Col., 16; M.S., Iowa, 17, fellow, 17–19, Ph.D., 19. Curator, Barnes Collection N. Am. Lepidoptera, 19–21; asst. prof. biol. Morningside Col., 21–22; *prof. zool., Denison, 22–* Asst. Prof. Franz Theodore Stone Lab., 28. Summers, bur. entom., U. S. Dept. Agr., 16–18. A.A.; Entom. Soc. Micros. Soc.; Ohio Acad. (v. pres., 28); fel. Iowa Acad. Ecology of insects; human biology; genetics; evolution, relations of heritage and environment.—From *American Men of Science,* fifth edition, page 677.

W. C. EBAUGH
Editor 1925–

Ebaugh, Dr. W(illiam) Clarence, Granville, Ohio. *Chemistry.* Philadelphia, Pa., Jan. 3, 77. B.S., Pennsylvania, 98, Ph.D., 01. Asst. and chief chemist, iron and steel lab., near Reading, Pa., 98–99; director pro tem., dept. physics and chem., Kenyon Col., 01–02; chemist, Am. Smelting and Ref. Co., and public analyst, Salt Lake City, 02–03; director dept. chem., Utah, 03–15; *prof. chem., Denison, 17,, ed., 'Jour. Sci. Labs,' Denison, 24–; consulting chemist, 02–* Visiting prof. Robert Col., Constantinople, 30–31. Assoc. ed., 'Jour. Indust. and Eng. Chem.,' 08–11. A.A.; Chem. Soc.; Eng. Educ.; West. Asn. Tech. Chem. and Metal; Utah Soc. Eng. (sec'y); Utah Acad. (pres., 09). Industrial chemistry; atomic weight of arsenic; steel analysis; pollution of atmosphere by smelter fumes; smelter smoke; gas producers.—From *American Men of Science*, fifth edition, page 314.

In April, 1927, the DENISON SCIENTIFIC ASSOCIATION celebrated its fortieth anniversary with appropriate exercises; at the Chapel Exercises distinguished alumni and invited guests addressed students and friends, a banquet was attended by many delegates from neighboring institutions and distinguished visitors, and a special number of the JOURNAL OF THE SCIENTIFIC LABORATORIES OF DENISON UNIVERSITY was issued in commemoration of the event. It is our hope that the celebration of the fiftieth anniversary of the Association in 1937 may be even more significant.

Respectfully submitted,

W. C. EBAUGH, *Permanent Secretary and Editor*

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